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RECRUIT APTITUDES AND ARMY JOB PERFORMANCE SETTING

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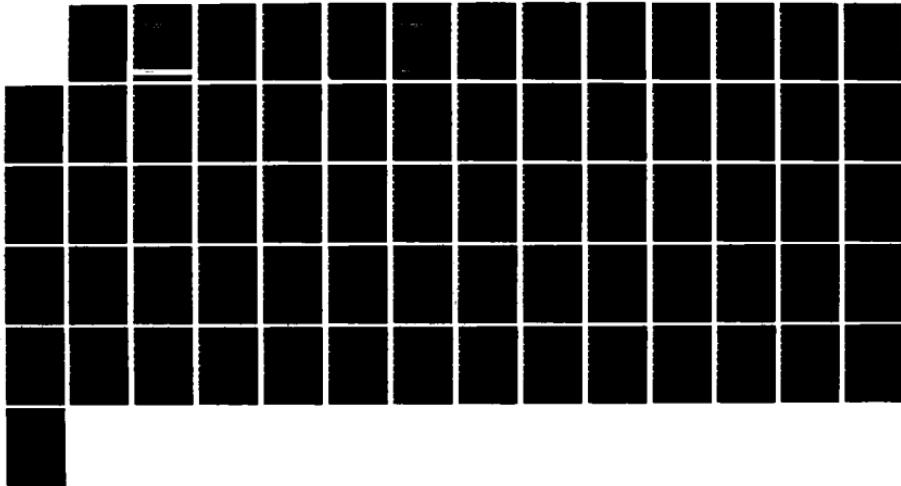
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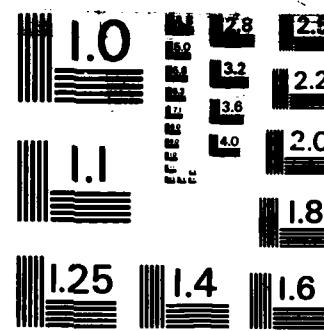
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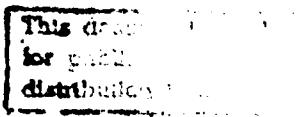
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Recruit Aptitudes and Army Job Performance

Setting Enlistment Standards for Infantrymen

David J. Armor, Richard L. Fernandez, Kathy Bers,
Donna Schwarzbach
With the assistance of S. Craig Moore, Leola Cutler

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The research described in this report was sponsored by the Office of the Assistant Secretary of Defense/Manpower, Reserve Affairs and Logistics under Contract MDA903-80-C-0652.

Library of Congress Cataloging in Publication Data
Main entry under title:

Recruit aptitudes and Army job performance.

"December 1982."

"R-2874-MRAL."

Bibliography: p.

1. United States. Army--Recruiting, enlistment, etc.
2. Armed Services Vocational Aptitude Battery. 3. United States. Army--Personnel management. I. Armor, David J.
II. United States. Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)
UB323.R38 1983 355.2'234'0973 82-21529
ISBN 0-8330-0460-3

The Rand Publications Series: The Report is the principal publication documenting and transmitting Rand's major research findings and final research results. The Rand Note reports other outputs of sponsored research for general distribution. Publications of The Rand Corporation do not necessarily reflect the opinions or policies of the sponsors of Rand research.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. AGENCY NUMBER R-2874-MRAL	2. GOVT ACCESSION NO. AD-A140 967	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Recruit Aptitudes and Army Job Performance: Setting Enlistment Standards for Infantrymen	5. TYPE OF REPORT & PERIOD COVERED Interim	
7. AUTHOR(s) David J. Armor, Richard L. F. Nandes, Kathy Bers, Donna Schwarzbach	8. PERFORMING ORG. REPORT NUMBER MDA903-80-C-0652	
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Rand Corporation 1700 Main Street Santa Monica, CA 90406	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Assistant Secretary of Defense/ Manpower, Reserve Affairs and Logistics Washington, D.C. 20301	12. REPORT DATE September 1982	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	13. NUMBER OF PAGES 58	
	15. SECURITY CLASS. (of this report) Unclassified	
	16. DECLASSIFICATION/DOWNGRADING SCHEDULE	
17. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) No restrictions		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Army Personnel Job Analysis Recruiting Aptitudes Performance Standards		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) see reverse side		

Presents findings from a study of the relationship between observable characteristics of military enlistees and their subsequent job performance, and the use of those relationships in a model for setting enlistment standards. Two performance measures are examined: retention (what portion of the initial enlistment tour is completed), and job proficiency. Recruit aptitudes are important predictors of success on the Army's Skill Qualification Test for infantrymen, and on earlier experimental hands-on tests for four other Army jobs. The performance results are combined with recent data on Army recruiting, training, and force-maintenance costs in a cost-performance trade-off model. The model yields an optimal enlistment standard for the Infantryman speciality that is close to that adopted in fiscal year 1981, and a quality mix for entering recruits about the same as the mix mandated by Congress. Adopting optimal standards Army-wide could cost \$100 to \$200 million.

R-2874-MRAL

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With the assistance of S. Craig Moore, Leola Cutler**

September 1982

**Prepared for the
Office of the Assistant Secretary of Defense/
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PREFACE

This report presents findings from a study of the relationship between recruit aptitudes and job performance in Army jobs, and the use of that relationship in a model for setting enlistment standards. The report documents a briefing presented to the Acting Assistant Secretary of Defense, Manpower, Reserve Affairs, and Logistics (MRA&L), on April 10, 1981, describing preliminary model results for the Army Infantry.

The report was prepared as part of Rand's Manpower, Mobilization, and Readiness Program, sponsored by the Office of the Assistant Secretary of Defense (MRA&L), under task order No. 81-IV-4, "Enlistment Standards and Job Performance."

SUMMARY

An improperly calibrated Armed Services Vocational Aptitude Battery (ASVAB) used between 1976 and 1980 produced inflated test scores for many applicants seeking military enlistment. In effect, the calibration error lowered enlistment standards and led to increased enlistment of low-aptitude personnel, many of whom would not have qualified with a correctly calibrated test. These low-ability recruits, called "category IV," are below the 30th percentile in general aptitude compared with the World War II mobilization population, and represent the lowest category allowed to enlist.

The calibration error was corrected for the 1981 fiscal year, but meanwhile the Army had experienced the largest influx of low-aptitude recruits among the services. This event raises three important policy questions, each of which is investigated in this report. First, what is the magnitude of this decline in Army recruit aptitude levels, and how does it compare with aptitude levels during the draft years? Second, how has this decline affected job performance and, hence, manpower effectiveness? Third, will higher aptitude standards for the Army be cost-effective, and, if so, how costly will these higher standards be?

The first question is answered by comparing recent Army recruit aptitude levels with those obtained during the 1960s when the draft was in effect. We find that, between 1976 and 1980, nearly one-half of all Army recruits fell into category IV. During the peacetime draft years, this proportion varied around an average of 20 percent. In other words, lowest-aptitude recruits more than doubled during the last half of the 1970s. Moreover, the proportion of highest-aptitude recruits (categories I and II, the top 35 percent of the general youth population) fell from around one-third to about 15 percent by 1980. Following adoption of a new and correctly calibrated aptitude test in late 1980, Army category I and II recruits climbed to 25 percent, while category IV recruits dropped to 31 percent for the 1981 fiscal year.

The effect of declining aptitude levels on job performance was evaluated by means of standardized on-the-job proficiency tests, which assess the extent to which enlisted personnel possess skills essential for specific Army jobs. Compared with higher-ability Army recruits, lower-aptitude recruits are much more likely to fail these on-the-job performance tests across a wide range of Army jobs, including combat arms specialties. Therefore, the declining aptitude levels in recent years have lowered Army manpower effectiveness by enlisting larger numbers of personnel who are unable to meet minimum skill requirements.

Given the relationship between aptitudes and job performance alone, the higher aptitude standards adopted by the Army in 1980 would clearly seem desirable. These standards follow a Congressional mandate setting a maximum of 25 percent category IV recruits for 1982 and 20 percent in future years. The final policy questions, then, become whether these new standards will be cost-effective in an All-Volunteer Army, and how much it will cost the Army to meet them. This report attempts to answer these questions by developing a methodology for determining optimal aptitude mixes according to cost-effectiveness criteria.

The central component of this methodology is a cost-performance model that compares the total cost of recruiting and maintaining first-term enlisted personnel of varying quality mixes for a given Army job. The quality mix varies according to AFQT distribution, high school status, and the aptitude score requirements for entrance into a given job. The model is applied to the Army Infantryman specialty for illustrative purposes.

The results for Army Infantrymen show that the model can generate a series of optimal aptitude mixes for various recruiting-cost assumptions. Generally speaking, the model shows that optimal aptitude mixes require a higher proportion of high-aptitude recruits than were enlisted between 1976 and 1980. Under the smallest of three recruiting-cost assumptions, the optimal standards are even somewhat higher than the new Infantry standards adopted for the 1981 fiscal year.

Assuming that present manning levels remain constant, raising ability standards will increase recruiting costs substantially. Although the recruiting-cost estimates need further refinement, preliminary estimates suggest that optimum ability mixes might cost the Army between \$100 and \$200 million per year in extra recruiting costs, either in the form of additional recruiters or in the form of enlistment bonuses or other enlistment incentives. Such expenditures would deliver only 7,000 additional high-ability men, out of an estimated 105,000 Army non-prior-service male accessions in 1981. If the Congressional mandate were applied to all Army jobs, this increment could rise to 10,000 or 12,000 high-ability recruits (or more) at an increased cost on the order of \$280 to \$370 million per year. Moreover, as the number of 18-year-olds in the general population declines throughout the 1980s, coupled with plans to increase the size of the Army, the competition for high-ability personnel may become even more intense. Recruiting costs may then have to rise even further to attract enough persons to meet these new ability standards.

Notwithstanding these seemingly high costs, this study has shown that higher ability standards make sense. Two points must be kept in mind. First, the additional costs are only a small increment to the total cost of recruiting and maintaining the first-term force; in the Infantry example examined here, achieving the optimal ability mix requires only about a 5 percent increase in total force costs. Second, the return that these additional expenditures will yield is a substantially more capable force; the optimal mix would yield 10 percent more working-months contributed by Infantrymen who are able to meet the minimum job performance standard. Higher standards ensure that more of the Army's recruits are able to perform their jobs adequately, reduce the cost of obtaining each month of qualified job performance, and hence may justify the costs they impose.

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I. THE POLICY PROBLEM

In July 1980, the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics reported to Congress that calibration errors had been discovered in the Armed Services Vocational Aptitude Battery (ASVAB), the test used to determine enlistment eligibility and assignment to specific jobs.¹ The errors consisted of incorrect test "norms" that caused lower-aptitude applicants to receive substantially inflated test scores. As a result, many persons were allowed to enlist between 1976 and 1980 who otherwise would not have met minimum aptitude standards either for specific jobs or for military service in general.

The Army was particularly affected. Before the error was discovered, it appeared that the Army was enlisting about 9 percent of its personnel in the lowest allowable category (called "category IV") on the AFQT, a composite of ASVAB subtests measuring general aptitudes. A person in this category has a score between the 10th and 30th percentiles of the World War II mobilization population, which is widely believed to represent the total U.S. youth population.² After the error was corrected, it turned out that nearly half of recent Army recruits were in this lowest acceptable category. For all services combined, it previously was believed that only 5 percent of recent recruits were category IV, but the true proportion was 30 percent.

Figure 1 shows the trends in low- and high-aptitude Army recruits over the past 20 years. During most of the 1960s fewer than 20 percent of Army recruits were category IV, except for a few years during the Vietnam conflict when the proportion rose to about 28 percent. After the draft ended, however, corrected aptitude scores show that the proportion of category IV personnel increased substantially, until by 1980 virtually one-half of all Army recruits fell into the lowest allowable mental category.

A less discussed but equally significant finding is the trend for category I and II recruits, who score in the upper 35 percent of aptitude levels. High-aptitude recruits dropped sharply, from one-third of all recruits in the draft years to 15 percent by 1980. During an era in which Army weapons systems have become increasingly complex and sophisticated, the proportion of enlisted personnel available for leadership and for high-skill maintenance has fallen to less than half what it used to be.

The test calibration errors were corrected in a new ASVAB adopted in October 1980. As shown in Fig. 1, this led immediately to a reduction in category IV recruits to 30 percent and an increase in category I and II recruits to 23 percent for the 1981 fiscal year. Note, however, that 1981 aptitude levels are still lower than the levels observed during the peacetime draft years.

Even though recent aptitude levels have been increasing, several important policy questions remain. First, has this large number of lower aptitude recruits caused manpower effectiveness to decline, especially in the Army, and if so, to what extent? Second, can the experience with lower standards indicate how to set standards in the future? That is, can information on the performance of low-aptitude recruits be used to determine an optimal aptitude mix? Of special interest is the cost-effectiveness of a recent Congressional mandate

¹Office of the Assistant Secretary of Defense (OASD/MRA&L), *Aptitude Testing of Recruits, A Report to the House Committee on Armed Services*, July 1980.

²Under public law, persons below the 10th percentile in general aptitudes are excluded from peacetime military service.

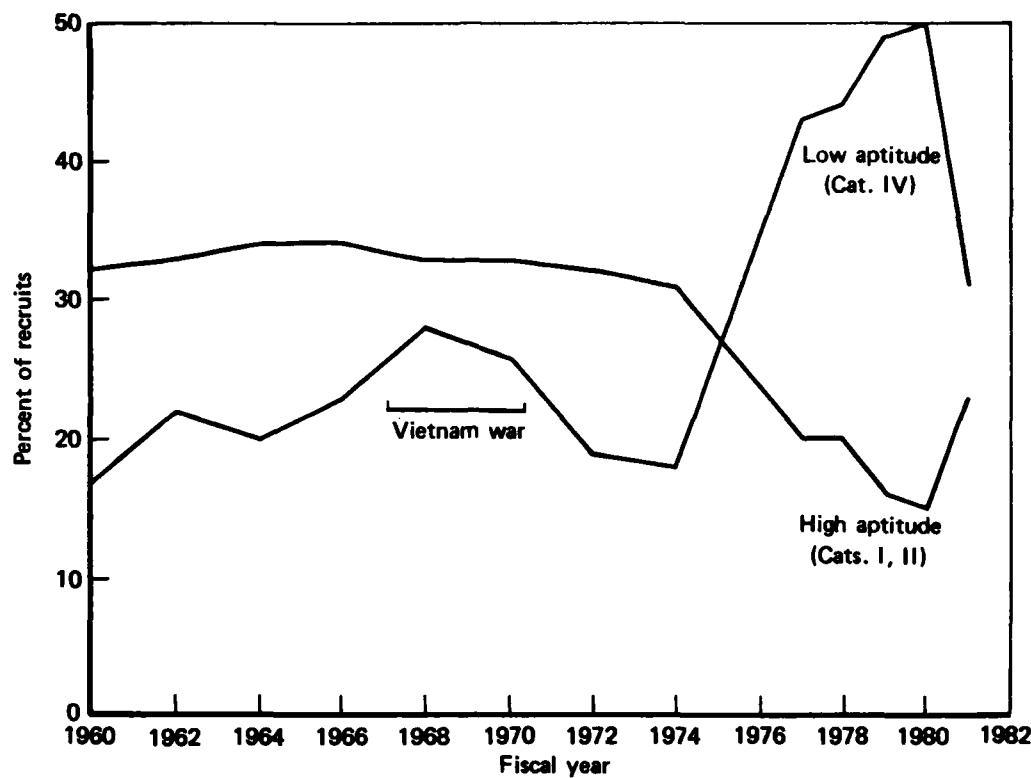


Fig. 1—Trends in high- and low-aptitude Army recruits

calling for ceilings of 20 percent category IV and 35 percent non-high-school graduates among new recruits within each service.

In the past, answering questions such as these has been complicated by the lack of adequate measures of manpower effectiveness. The traditional justification for limiting enlistments of category IV personnel rests on their lower grades in training schools. However, given the importance of reading and writing skills in classroom settings, schooling results may not necessarily predict actual on-the-job performance, particularly among manual or combat-related jobs. Up to this point, ability standards have not been officially justified by an examination of on-the-job performance.

With the advent of the Army's unique Skill Qualification Test (SQT), on-the-job performance tests are now available. The SQT was developed for most Army jobs during the 1970s to help unit commanders assess training needs. The SQT tests the competence of personnel in understanding and performing selected tasks considered critical for a particular Army job. The SQT has both written and hands-on components unique to each job, and it has a specific passing score that defines minimum acceptable proficiency for that job.

The relationship between AFQT category and passing the 1979 SQT is shown in Fig. 2 for first-term Army Infantrymen.³ Regardless of high school status, men in category IV (revised norms) are more likely to fail the minimum SQT standard than are persons in higher categories. Although this issue will be explored in more detail later in this report, it does appear that recruit aptitudes can affect job performance. Therefore, the higher proportion of low-aptitude recruits in recent years appears to have degraded the effectiveness of Army Infantry personnel.

³MOS 11B.

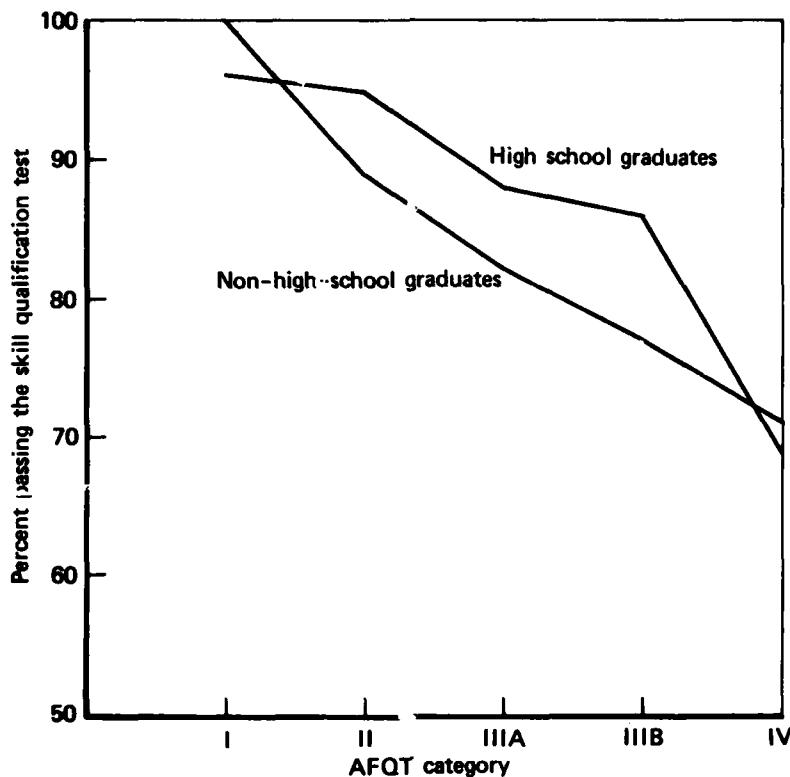


Fig. 2—General aptitude and job performance for Army Infantrymen

This still leaves the question of how to set aptitude requirements in the future, which is a major topic of this report. Merely showing a correlation between recruit aptitude and on-the-job performance does not itself establish aptitude standards for a given job. One reason is that many category IV persons do qualify on the SQT, albeit at a lower rate than higher-aptitude recruits. Moreover, the SQT is not the only indicator of personnel effectiveness; other performance indicators, especially training results and attrition, must be considered. Persons who fail training courses or who separate before the end of their enlistment term also detract from effectiveness by increasing training loads and by creating job turbulence. Nor should the factor of cost be ignored. High-ability enlistees may out-perform low-ability enlistees, but they also cost more to recruit. The cost trade-offs between the higher recruiting cost of high-ability personnel and their superior performance must therefore be considered.

The major objectives for the remainder of this report are three-fold. First, the relationship between job performance and various ability characteristics is examined in some detail, focusing on several Army jobs and using performance data from several sources. To assess the potential effect of differing ability standards on the Army as a whole, it is important to test the relationship between job performance and aptitudes for more than one Army job and use more than one ability indicator.

Second, a methodology is presented for investigating the cost-effectiveness of alternative enlistment standards for specific military jobs, where standards are defined in terms of aptitude and educational requirements. The methodology is a cost-performance model that allows

investigation of optimal ability standards or mixes, where optimum means an ability mix that minimizes cost per unit of performance for a given force size.

Finally, this methodology and model are illustrated for the Army Infantryman specialty, using recent cost and performance data. The intent here is to show how the model works and to compare optimal standards with the cost-effectiveness of past, present, and proposed future standards for Infantrymen.

The report is organized into four remaining sections. Section II discusses performance measures for Army jobs and presents the basic relationships between job performance and personnel characteristics using recent Army data. Section III describes the cost-performance model for assessing the cost-effectiveness of a particular ability mix, along with cost estimates necessary for applying the model to Army Infantry. Section IV applies this model to the Infantry performance data in Section II, and discusses the implications of this methodology for setting future enlistment standards. Section V summarizes the principal study findings, and discusses their implications for Army-wide enlistment standards policy and recruiting costs.

II. PERFORMANCE MEASURES FOR ARMY JOBS

Traditionally, military aptitude standards have been established by relating aptitude scores to performance criteria based on training-school outcomes. While this type of relationship is useful, it is by no means a complete answer for setting aptitude requirements. What happens in a training school is not necessarily representative of what happens on the job; the classroom can only approximate the practical day-to-day conditions and demands of the real job environment. This approximation may become close, but a possibility remains that the kinds of abilities needed to do well in a classroom setting will not be the same as those needed on the job. If the abilities do differ, then the abilities needed for on-the-job performance should clearly take precedence.

Another criterion used for setting current enlistment standards is attrition prior to the normal end of term. Obviously, a person's job proficiency is immaterial if the person leaves the military prematurely. Attrition has become a problem for all military services; it leads to larger recruiting quotas and hence greater recruiting and training costs to maintain desired manning levels. Many studies have shown that the major determinant of military attrition is high school status, with non-high-school graduates far more likely to separate prematurely than high school graduates (e.g., Buldin, 1981). For this reason, recent enlistment policies have tended to emphasize recruitment of high school graduates, regardless of aptitude levels.

The problem with existing standards is that neither training success nor attrition assesses on-the-job performance, and therefore recent enlistment standards may or may not be related to actual job behavior. One reason that training and attrition have played major roles in setting enlistment standards is that, until recently, adequate on-the-job performance measures have not been available. The Army Skill Qualification Test (SQT) changes this circumstance to a large extent.

The SQT was originally designed to evaluate training needs. It is an objective test that assesses proficiency in representative tasks deemed essential to carrying out specific job responsibilities. The test is developed and revised by special staff at each training school, with input from field commanders to ensure that the tasks included in the SQT remain essential to the job in question. The unique feature of the SQT is its format. It contains a written component to assess job knowledge; a hands-on component to test actual behavioral proficiency in critical tasks (e.g., breaking down and reassembling the M-16 rifle; proper aiming and firing sequence of a tank cannon); and a supervisor's certification component that signifies other special qualifications (e.g., rifle range proficiency).

Although the SQT was not intended to assess individual performance, there is nothing inherent in its design to prevent its utilization for this purpose. Moreover, since it is administered once a year to most enlisted personnel (with a minimum of 3 months on-the-job experience) by an independent testing staff, a large and reasonably reliable data base exists for analyzing the relationship between the SQT and enlistment characteristics.

It must be emphasized that the SQT does not capture all aspects of actual on-the-job performance. As a proficiency test, the SQT does not assess such dimensions as actual hours worked, cooperation with supervisors and co-workers, and related work habits. Nevertheless, it captures more of the essential aspects of on-the-job performance than any other objective

measure available at this time, and it is therefore a serviceable tool for evaluating enlistment standards.¹

CORRELATES OF PERFORMANCE

The three performance measures discussed so far—training success, attrition, and the SQT—can affect enlistment standards only to the extent that they are related to observable recruit characteristics. The entry characteristics of greatest policy interest are AFQT scores; special aptitudes unique to certain types of jobs, also derived from the ASVAB (e.g., Combat Arms aptitude, Mechanical aptitude, etc.); and high school status (graduates versus non-graduates). In addition, there is some interest in such demographic characteristics as age, region of country, race, and sex (for noncombat jobs), to the extent that they can be affected by recruiting policies.

Most analyses reported in this section are confined to first-term Army Infantrymen, where first-term is defined as the first 36 months of service.² Although performance of career personnel is also important, the enlistment standards model developed here is applied only to first-term personnel, who account for most of the attrition and SQT failures. The FY 1977 accession cohort, consisting of approximately 14,000 Infantrymen who can be tracked for three years (until September 1980), was used for training and attrition outcomes. SQT results were based on the Fall 1979 administration of the SQT for persons with up to three years of service (skill level 1), which yields scores for about 8,000 Infantrymen.³

Training and Attrition

The substantial association between high school status and attrition, both during and after training, is shown in Fig. 3, which presents retention rates of Infantrymen during the first 36 months of enlistment. At the time these data were collected, training could be broken down into two components, basic and advanced.⁴ Non-high-school graduates in this cohort dropped out of basic training at a higher rate than graduates (15 percent versus 8 percent, respectively), and this differential continued throughout the first term. By the end of 36 months, which was the end of the first term for most of these Infantrymen, less than half of the non-high-school graduates remained on active duty, compared with 70 percent of the graduates. From the standpoint of attrition alone, high school graduates clearly offer an advantage over nongraduates.

Interestingly, no entry characteristics other than high school status were found that correlate strongly with either training completion or post-training attrition in the Army Infantry. Most important, neither AFQT nor the special vocational aptitude score used to qualify for Infantry—Combat Arms aptitude—is significantly related to training success or attrition. For example, Fig. 4 compares Combat Arms scores with rates of advanced Infantry training completion, and reveals virtually no relationship between the two.⁵ The reason may

¹Supervisors' ratings are frequently advocated as on-the-job performance measures, but operational supervisor ratings have two critical flaws: They usually show little variation from one person to another, and they are subjective, not objective, measures.

²About two-thirds of recent 11B accessions are three-year enlistments.

³Generally, one must be on active duty for 12 months to take the SQT, but there are small numbers of men who take it with less than 12 months of service.

⁴Basic and advanced training are now combined for Infantrymen.

⁵The Combat Arms scores are from the ASVAB in use during FY77, but have been correctly renormed. The old qualifying score for Infantry, on the renormed basis, is 76.

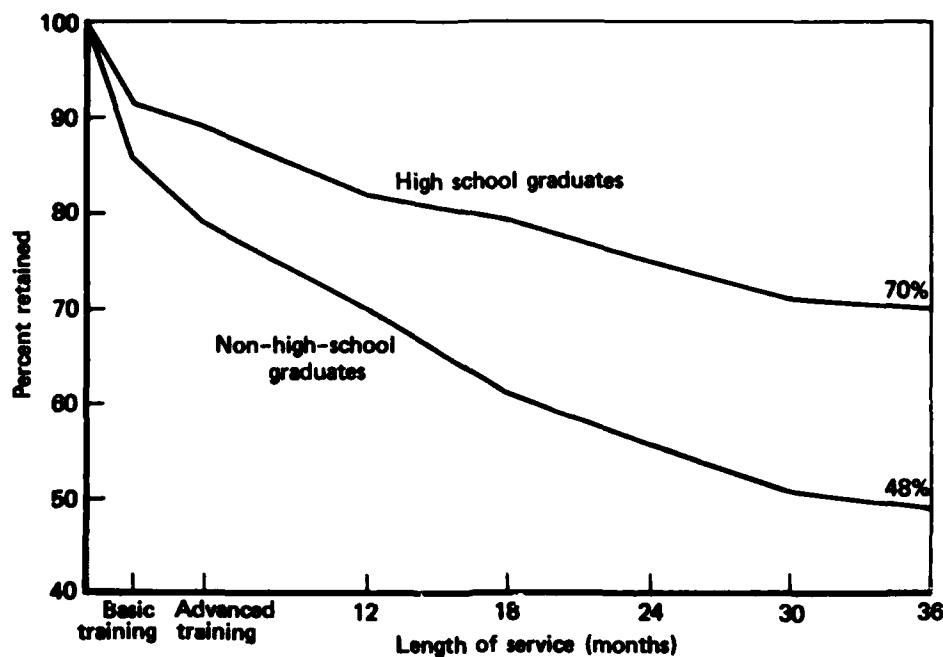


Fig. 3—Length of service and high school status for first-term Army Infantrymen

be that the standard for passing combat training is set relatively low, so that most persons at all aptitude levels can pass.

A similar relationship between AFQT and attrition during the first 36 months of service is shown in Fig. 5. Apart from the anomaly of high completion rates among category I and category IVC nongraduates, which is probably attributable to randomness in the data and the small number of such individuals in the sample, a strong and consistent relationship is visible between high school status and remaining in the Army, but virtually no relationship between AFQT and attrition.⁶

Likewise, there is no strong or consistent relationship between attrition and most other demographic characteristics, such as age and region of country. There is a slight relationship for race, with black enlistees having about a 5 percent lower attrition rate than white enlistees after controlling for high school status.

SQT Pass Rates

A multivariate analysis was undertaken to investigate the predictors of SQT pass rates. The analyses showed that the strongest predictors of passing the SQT were Combat Arms (CO) aptitude scores and AFQT scores. Although these two variables are highly correlated, regression coefficients for both were statistically significant at the 5 percent level. In addition, high school status and time in the service had small but statistically significant rela-

⁶Categories IVA, B, and C are finer breakdowns of the AFQT, with category IVC the lowest (10th to 15th percentile).

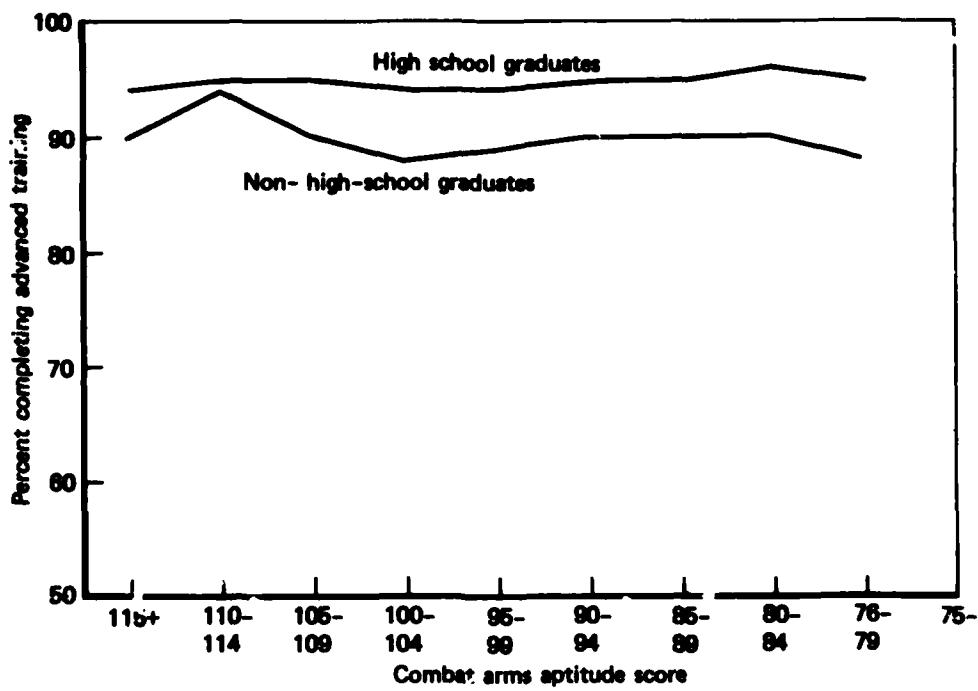


Fig. 4—Completion of advanced training by Army Infantrymen who start training

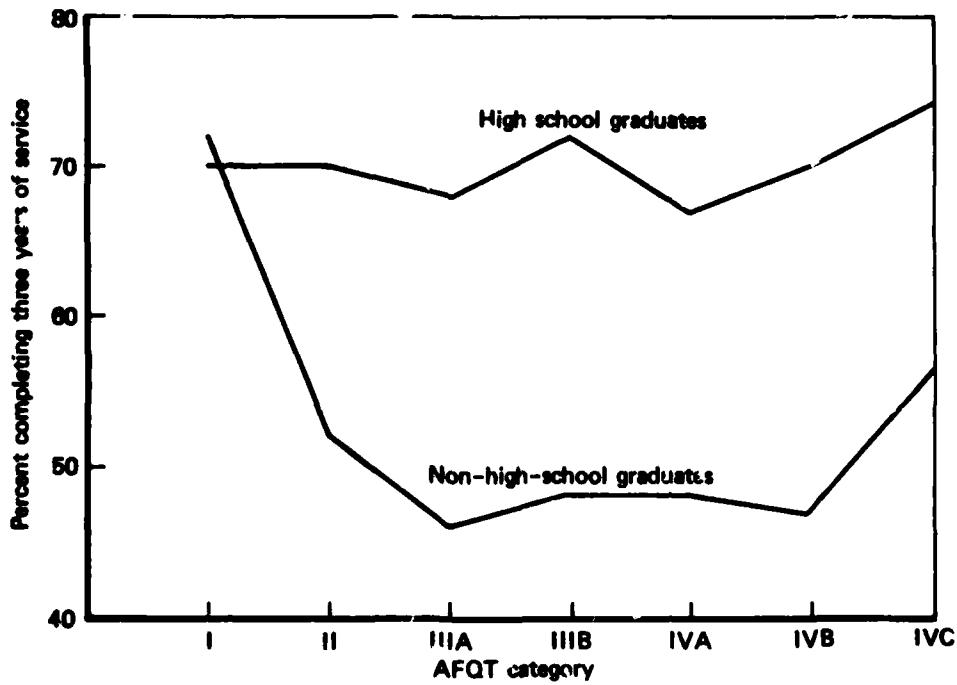


Fig. 5—First-term retention for Army Infantrymen

tionships with passing the SQT. Other demographic characteristics had no important predictive effects once these four characteristics were taken into account.

The strengths of these various relationships are evident in Fig. 6.⁷ Only about 60 percent of Infantrymen with CO scores less than 80 passed the SQT, compared with better than 90 percent pass rates for those with scores over 100. An increment of 10 points on the CO test means that an additional 10 percent of Infantrymen will pass the SQT, regardless of high school status and time in service.

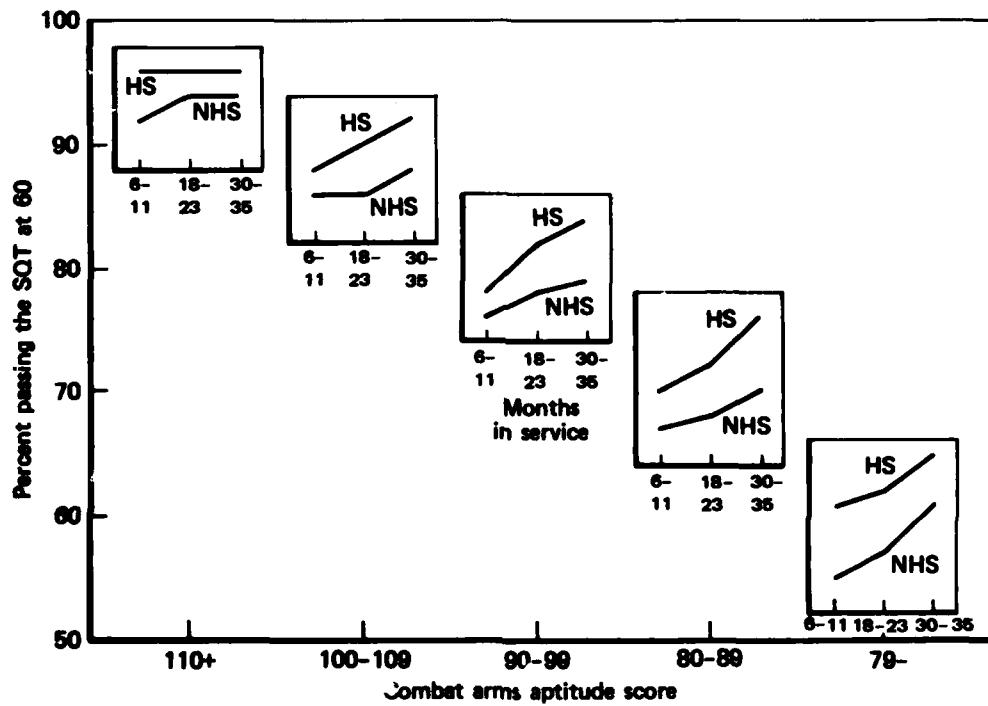


Fig. 6—Job performance, ability indicators, and time in service for Army Infantrymen

By contrast, within each aptitude group, high school graduates have SQT pass rates only a few points higher than nongraduates. Therefore, a nongraduate with a high CO score is much more likely to pass the SQT than a high school graduate with a low aptitude score. Moreover, time in service does not overcome the disadvantage of a low CO score. Within each ability group, those who have completed nearly three years of service have an SQT pass rate only about 5 points higher than those with one year of service. Thus high-aptitude men who are fairly new to the Infantry are more likely to pass the SQT than low-aptitude men with substantial experience.

It should be noted that the qualifying Combat Arms score for entry into the Infantry was 90 prior to October 1980, based on the incorrectly normed ASVAB. After the test norms were corrected, the original qualifying score of 90 was equivalent to a corrected score of 76. As of

⁷The pass rates are estimated from a logistic regression of SQT pass rate using Combat Arms, high school status, time in service, and AFQT as independent variables.

October 1980, the Army raised the Combat Arms cut-off score for Infantry to 85, so that during FY 1981 no new recruit should fall into the lowest ability level shown in Fig. 6.

The most important finding of this analysis so far is that high school status and aptitude have very different effects on job performance. The former strongly predicts attrition but not (to any great extent) on-the-job proficiency, while the latter strongly predicts job proficiency but not attrition. Since both attrition and on-the-job performance are important in determining the effectiveness of military manpower, enlistment standards must take into account both aptitude and high school status.

What is not clear, however, is the trade-off between high-aptitude nongraduates on the one hand and low-aptitude graduates on the other. Recent enlistment policies tend to favor the latter group, in spite of their low proficiency on the SQT. The extent to which this is the most cost-effective policy is tested by the model introduced in Sec. III.

ALTERNATIVE PERFORMANCE MEASURES

The SQT does not measure all aspects of on-the-job performance, nor is it without other reliability problems. Indeed, it is unlikely that any measure of job performance will ever be completely free of methodological limitations. Like many measurements of complex human behavior, the SQT score serves as an index of the underlying phenomenon rather than a direct measure of the phenomenon itself.

Such limitations lead to the question of whether the relationships shown between the SQT and recruit aptitudes in Figs. 2 and 6 are idiosyncratic properties of this particular test or job, or whether they hold up for other performance measures and other jobs as well. Many analysts would be especially concerned with the written component of the SQT, since any two paper-and-pencil tests may tend to have some correlation due to reading ability or test-taking skills alone, independent of job skills. Hence some part of the correlation between SQT and aptitude scores could be spurious, caused by factors other than actual job performance.

Another concern with the SQT arises because unit commanders are encouraged to administer the hands-on (nonwritten) component of the test as a training aid, outside of the regular testing situation. Such rehearsal sessions are known to increase in frequency as the SQT administration date approaches, and therefore the possibility of a "practice effect" arises. A practice effect could result in higher than expected scores for some persons, a temporary inflation that would not be retained. For these reasons we are interested in alternative measures of on-the-job performance, especially measures that are strictly hands-on and that are administered in controlled settings without rehearsals.

One set of alternative job performance measures is available from project UTILITY, conducted by HumRRO in the late 1960s in connection with Project 100,000 (Vineberg and Taylor, 1972).⁸ The HumRRO project developed hands-on behavioral performance tests in four low- to moderate-skill Army jobs: Armor Crewman, General Vehicle Repairman, Supply Specialist, and Cook. These hands-on tests were actually research prototypes for the SQT, although the SQTs now in use differ considerably from the HumRRO tests because of the written component. As research tools, the HumRRO tests included a much larger sample of job tasks than the SQT and were administered in controlled settings by a special research team. Accordingly, the HumRRO data allow an investigation of the relationship between

⁸Project 100,000 was a policy experiment in which larger numbers of category IV personnel were inducted into the military.

mental ability and job performance in several Army jobs using a reliable and strictly hands-on test.⁹

The relationship between AFQT scores and passing the HumRRO performance tests is shown in Fig. 7, along with the Infantryman SQT results. Since a "minimum standard" passing score was not defined for the HumRRO tests, a passing score is defined here as that score at which about 95 percent of career personnel would pass.¹⁰

The relationship between AFQT and on-the-job proficiency is remarkably consistent from job to job, and virtually identical to the SQT result for Infantrymen. For all jobs, category IV personnel are substantially less likely to pass the performance tests than higher-aptitude personnel. Armor Crewmen and Cooks have slightly lower pass rates overall, but the strength of the relationship with AFQT is virtually the same, with a 30-point spread in pass rates from the highest to the lowest AFQT categories. Therefore, the relationship between general aptitudes and the Infantry SQT is not a spurious result arising from unique properties of the SQT, such as its written component, nor is it a result confined to Infantrymen alone.

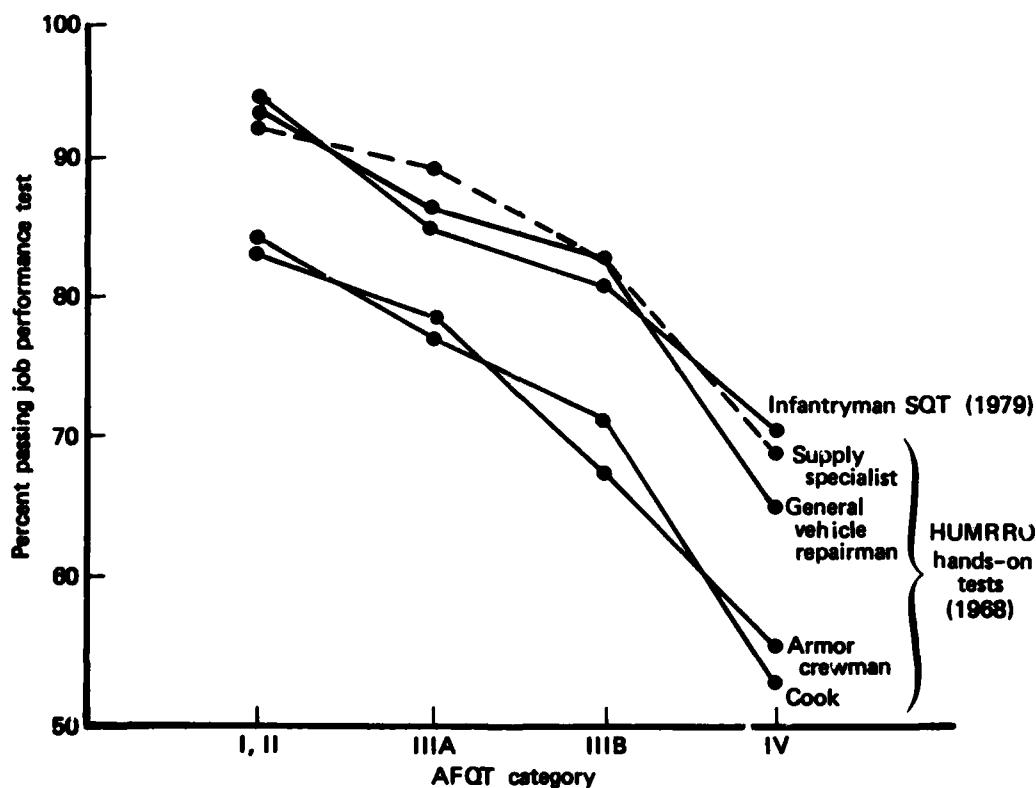


Fig. 7—General aptitude and job performance in five Army specialties

⁹Internal consistency reliability coefficients are .93, .84, .87, and .56 for the Armor, Repair, Supply, and Cook tests, respectively.

¹⁰About 95 percent of career Infantrymen (grade E5) pass the SQT at the minimum qualifying score of 60. Passing scores were 50 percent correct for all jobs but Supply Specialist, where the passing score was 40 percent.

A further validity test for the Infantryman SQT can be obtained by examining the relationship between aptitude levels and the hands-on subtest. This relationship is shown in Fig. 8, using Combat Arms aptitude scores as a predictor of the percent attaining scores of 90 percent on the hands-on subtest. The criterion of 90 percent is fairly high, but it is justified by the fact that the 1979 hands-on subtest for first-term men includes only 14 of the most basic and critical Infantryman tasks, all of which could be practiced repeatedly prior to the official testing day.¹¹ A score of 90 percent could easily be adopted as the journeyman standard for this test.

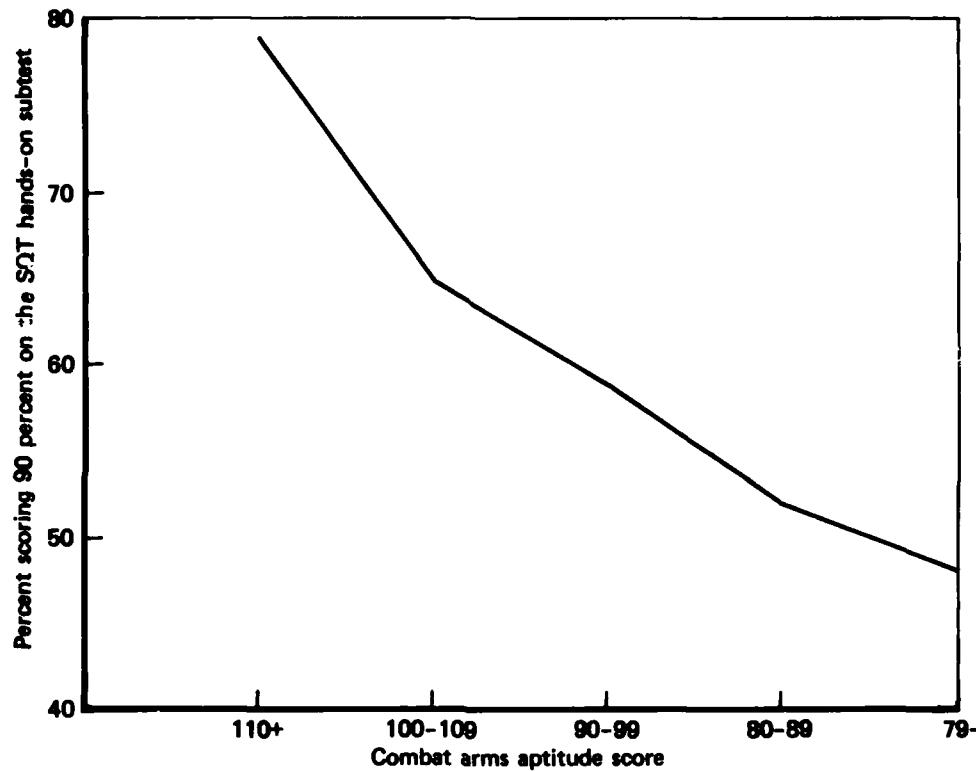


Fig. 8—Aptitude and hands-on performance for the Infantry SQT

The relationship between aptitude and the hands-on Infantry test resembles that shown for the total SQT in Fig. 6. Less than half of persons scoring below 80 on Combat Arms aptitude achieve a score of 90 percent on the hands-on test, compared with better than two-thirds of those with aptitude scores over 100. The relationship shown here is replicated for the hands-on component of the 1978 and the 1980 Infantryman SQT.

¹¹The tasks are: Install telephone set; operate a field radio; transmit and receive a radio message; install a Claymore mine; determine magnetic azimuth using a compass; prepare M72 LAW and engage target; stop bleeding of arm or leg and identify shock symptoms; perform operator maintenance on M16A1 rifle; use a protective mask; use hand grenade; decontaminate self; perform operator maintenance on M60 machine gun; operate M60 machine gun; use the M203 grenade launcher.

The conclusion from this analysis is inescapable. Recruit aptitude levels strongly affect subsequent job performance, not only for Infantrymen but for a representative variety of other Army personnel as well. This relationship holds up even when job performance is measured by nonwritten, strictly hands-on tests. We must conclude, then, that the reduced aptitude levels of recent recruits appear to have diminished Army manpower effectiveness.

III. A MODEL FOR SETTING ENLISTMENT STANDARDS

The relationships between the various performance criteria and entry characteristics shown in Sec. II do not in themselves determine enlistment standards. Of course, from the viewpoint of maximizing job performance alone, the military should recruit as many high-ability high school graduates as it possibly can. But many other goals and constraints shape enlistment policies, some of which conflict with the single objective of maximizing job performance.

Cost considerations are critical. A force composed entirely of high-ability personnel might be less cost-effective than a mixture of both higher- and lower-ability recruits. The reasons for this are that (1) recruiting costs are higher for high-ability personnel and (2) many category IV persons can qualify on the SQT, albeit at a lower rate. There are also broader issues to be considered, such as the concept that responsibility for national defense should be borne by all citizens, not primarily by one social group or another. This leads some analysts to recommend a recruiting policy that aims to enlist a representative cross-section of the American population (Moskos, 1980).

Not all of these considerations can be quantified in a way that leads to specific enlistment standards for each military job. Given the present All-Volunteer Army, one feasible approach for developing enlistment standards utilizes cost-effectiveness objectives. The cost-effectiveness approach examines whether there are enlistment standards for a given military job that minimize the cost of achieving given levels of job performance.

To answer this question, a model must be formulated that relates job performance to enlistment characteristics and allows calculation of force-cost figures for a given level of job performance. After various force-cost parameters are estimated, this cost-performance model can be applied to differing enlistment standards and ability mixes to investigate those standards that produce the most cost-effective job force.

THE PERFORMANCE MODEL

The basic concept of our model is that of a *qualified man-month*.¹ A qualified man-month arises from each month of post-training duty time contributed by a person who can pass the SQT at the minimum standard. We model the number of qualified man-months as a function of various personnel characteristics at entry to military service. A simple accounting function relates qualified man-months (Q) to enlistment characteristics:

$$Q = A \sum_i [P_i B_i T_i \sum_t (R_{it} S_{it})], \quad (1)$$

¹The basic approach used here builds upon earlier unpublished work by Major Eugene Steadman, Jr., USAF, of OASD(MRA&L). The particular form of Eq. (1) was developed at Rand by Craig Moore and David Armor.

where i = category of entry characteristic (e.g., high school graduate in category IV)
 t = time in service, in months
 A = number of accessions
 P_i = proportion of accessions in category i
 B_i = proportion of category i accessions completing basic training
 T_i = proportion of category i basic graduates completing advanced training
 R_{it} = proportion of category i advanced graduates completing t months of service
 S_{it} = proportion of category i retained accessions able to pass the SQT at month t

Each of the parameters B , T , R , and S are functions of those entry characteristics found to predict training completion, retention, and SQT performance.

To illustrate how this model works, consider a hypothetical group of 100 accessions in a particular ability group (e.g., high school graduates in AFQT category IIIA with Combat Arms scores between 100 and 105). Assume that 90 percent complete both Basic and Advanced training; this leaves 90 persons in the accession group. Assume further that 30 persons remain in the military for an additional 10 months, 30 remain for 20 months, and 30 remain for 30 months of post-training active duty. If the SQT pass rates for this ability group are 80 percent, 85 percent, and 90 percent at these three time-in-service points, respectively, then the 90 men contribute 1560 qualified man-months $[(30 \times 10 \times 0.8) + (30 \times 20 \times 0.85) + (30 \times 30 \times 0.9)]$. If desired, this number could be divided by 12 to obtain 130 qualified man-years. Carrying out such computations for all ability groups and summing would yield total qualified man-months for a given job.

The categories of entry characteristics indexed by (i) do not have to be the same for each retention or pass rate. They should reflect those entry characteristics related (or potentially related) to the pass rate in question. For example, in applying the model to Army Infantrymen, B is estimated as a function of both high school status and AFQT category; T is estimated as a function of high school status and Combat Arms group; and R is estimated as a function of high school status and AFQT category. These various rates can be estimated from simple cross-tabulations or from regression functions. For the Infantry application, cross-tabulations are used for B , T , and R based on the 1977 accessions cohort. Because of the number of variables involved, a logistic regression is used to estimate S (pass/no pass) as a function of Combat Arms score, high school status (graduate vs. nongraduate), AFQT, and time in service.²

For an existing accession group, such as 1978 Infantry accessions, all parameters in the model can be estimated using historical Army data. To investigate the effect of differing aptitude standards, P must be altered to reflect higher or lower cut-off scores on the aptitude test used for that occupation (Combat Arms in the present example), subject to additional requirements for AFQT and high school status, and a new Q computed. Several assumptions must be made in order to alter P and to compute a new Q .

First, in the Infantry application a constant (steady-state) force size is assumed—that is, constant retained man-months. Retained man-months (M) is given by:

²The logistic regression estimates the function (suppressing subscripts denoting observations):

$$S = 1/(1 + e^{-(a + \sum b_j X_j)})$$

where the X 's are the independent variables, a and the b 's are parameters to be estimated, and e is the base of natural logarithms.

$$M = A \sum_i [P_i B_i T_i \sum_t (R_{it})] \quad (2)$$

where all terms are as defined in Eq. (1). The reason for a constant force size is that manpower levels may be determined by broad considerations of division strength, manning requirements for weapons systems, optimal unit sizes, and so forth. Therefore, changes in the number of *qualified* men do not necessarily affect the total number of men needed to fill manpower quotas. Alterations of P change qualified man-months (Q), but the number of retained man-months (M) will not vary. To hold M constant, Eq. (2) is applied to the "baseline" case (pre-1981 enlistment standards) using 1981 projected accessions for A , which is about 12,000 men. The value M is computed, and for each new ability mix P' , Eq. (2) is solved for A' , as follows:

$$A' = \frac{M}{\sum_i [P'_i B_i T_i \sum_t (R_{it})]} \quad (3)$$

If a new ability mix has more high school graduates, for example, then a smaller number of accessions (A') can produce the same retained man-months (M) since graduates have lower attrition rates than nongraduates.

It needs to be stressed that the assumption of a constant total force size (allowing qualified man-months to vary in response to differing aptitude standards) is not a critical assumption for investigating optimal enlistment standards. It is also possible to hold qualified man-months constant, allowing total man-months to vary until an optimum is found, and then repeating the model for a different starting number of qualified man-months until a second optimum is found, and so forth. An optimum will exist for each different qualified force size, thereby making a clear analytic distinction between an optimal ability mix on the one hand and the total size of a force on the other. This second approach is illustrated in App. C.

The second assumption has to do with the distribution of persons within P' after raising (or lowering) the Combat Arms cut-off score from its pre-1981 value of 76.³ When the Combat Arms score is raised, new recruits are assumed to be distributed in proportion to their recent shares among recruits above that new cut-off score. This is called the "proportionality" assumption, which can be expressed as:

$$P'_i = P_i / \sum_i P_i^*, \quad (4)$$

where P'_i is the assumed new proportion of persons in category i , and P^* is the matrix left after eliminating a particular category of Combat Arms scores from the original P matrix.

One major exception is made to Eq. (4) for the Infantryman example discussed in Sec. IV. Since current Army standards do not permit enlistment of category IV non-high-school graduates, for all new ability mixes investigated here P_i^* and P'_i are set to 0 for this category of recruits, and the proportionality assumption is applied to all remaining categories.

Figure 9 shows the ability mixes resulting from raising the Combat Arms cut-off score from its pre-1981 value of 76 to 115, in 5-point increments, applying the proportionality

³The old standard of 90 on the Combat Arms aptitude test translates to a score of 76 when the norms are corrected.

assumption and the further constraint that no category IV nongraduates are enlisted. At the pre-1981 cut-off score of 76, recent Infantry recruits consisted of 49 percent non-high-school graduates and about 50 percent category IV, and about 25 percent were category IV nongraduates. As the Combat Arms score is raised, and category IV nongraduates are eliminated, the percent in category IV drops considerably and nearly disappears with cut-off scores above 100. The percent nongraduates also drops, primarily because category IV nongraduates are made ineligible. It should be noted that for a Combat Arms cut-off score of 85, the proportionality assumption generates an Infantry ability mix very close to the Congressional ceilings mandated for the services starting in 1983 (35 percent nongraduates and 20 percent category IV).

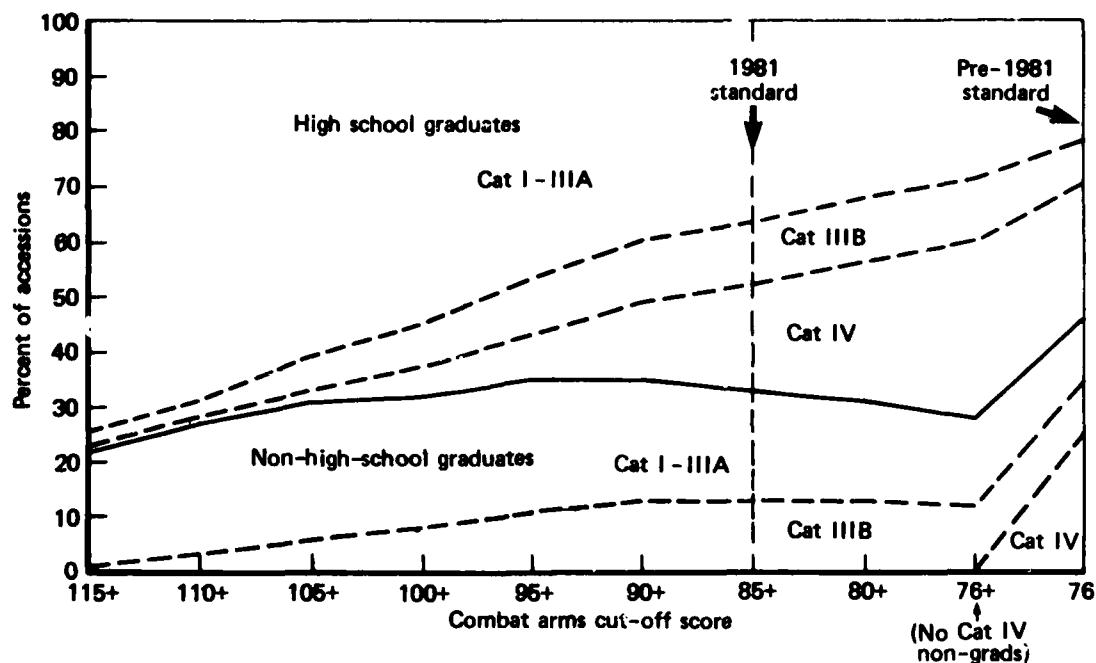


Fig. 9—Change in ability mix for differing Combat Arms cut-off scores

The model also allows specifications of additional constraints on high school status and AFQT category. For example, one might specify a maximum of 30 percent nongraduates and 25 percent category IV, all of whom must be graduates. After the constraint is applied, the model varies the Combat Arms cut-off score using the proportionality assumption (4) *within* AFQT and high school status groups specified by the constraints.

THE COST MODEL

The performance model specified by Eq. (1), taken alone, is not sufficient for finding an optimal ability mix. One might wish to maximize the proportion of retained men and the proportion of these men who are qualified (i.e., pass the SQT) for a specified number of accessions, but this approach would not generate an optimum solution except in the trivial

sense that "more" is better than "less." To derive a meaningful optimization strategy, one needs to consider the cost of obtaining that "more" by imposing a cost model on the performance model.

The cost model yields the cost of recruiting and maintaining a given qualified force as implied by Eq. (1). Assuming a constant total force size, variations in ability mixes will yield differing costs per qualified man-month. These variations can be used to investigate those ability mixes that minimize force costs per qualified man-month.

Force costs can be broken into four major components: (1) cost of recruiting, including advertising and special enlistment benefits and bonuses offered to high-ability personnel; (2) cost of initial entry and basic training; (3) cost of advanced training in a specific job; and (4) cost of the retained force in the post-training period, including pay, allowances, and base support activities (medical, commissary, recreation, etc.). Since the model is concerned mainly with differences in costs given differing numbers of persons in various ability groups, only variable costs will be estimated, or those costs which vary with changes in the number of personnel in the force. Total variable costs for the Infantry are merely the sum of these four component costs:

$$C = C_A + C_B + C_T + C_R, \quad (5)$$

where C_A stands for recruiting costs, C_B for basic training, C_T for advanced training, and C_R for post-training retained force costs.

Cost of Recruiting

The first cost component, and the most difficult to estimate, is the cost of recruiting. Unfortunately, there is far less information on how much it would cost to attract a greater (or lesser) number of high-ability recruits to the Army than there is for the other components.

The cost of recruiting is defined to include not only recruiter salaries, travel, and advertising expenses, but any special bonuses or educational benefits designed to attract higher-ability recruits. Although bonuses and educational benefits could also be viewed as part of enlistee pay and allowances, treating them as recruiting costs allows an investigation of trade-offs among various strategies that might be adopted by the Army to increase the supply of high-ability personnel.

Given the limited number of studies on the responsiveness of enlisted supply to various factors, two alternative recruiting-cost methods were adopted in this study, based on empirical estimates of supply elasticities.⁴ Existing studies have established significant supply elasticities for bonuses (treated as wage increases) and for the number of recruiters. Therefore, the first approach is to increase the supply of higher-ability personnel by offering *enlistment bonuses* to qualified recruits; the second is to increase the number of *recruiters*. It would also be desirable to use an educational benefit approach, since this is a popular policy option currently being considered for attracting more high-ability recruits. Unfortunately, at this time there are no response estimates available for this type of educational benefit packages being tested today.⁵

Both the bonus and the recruiter methods make the following common definitions and

⁴The formulas and estimates used in this section are based on unpublished work by Richard Fernandez.

⁵Such estimates are planned for future reports, based on Rand's analysis of the FY81 Educational Assistance Test Program.

assumptions: High-ability recruits are defined as high school graduates in AFQT categories I to IIIA (at or above the 50th percentile), and they are assumed to have various marginal costs (depending on the method) as discussed below. Low-ability recruits are non-high-school graduates or those in AFQT categories IIIB or IV, and are assumed to have marginal costs equal to 0. That is, there is an excess supply of lower-ability recruits (for the alternative ability mixes tested), so that additional lower-ability recruits require no further increases in recruiting costs. This last assumption may not be valid, particularly given the AFQT renorming, which places many former category IIIA personnel into category IIIB. It is the only assumption that can be made at this point, however, because existing studies have developed elasticity estimates only for high-ability recruits as defined above.

This approach is probably conservative in the sense of exaggerating the cost of higher-ability recruits relative to lower-ability recruits. If low-ability personnel are discovered to have marginal recruiting costs greater than zero, then the most cost-effective ability mixes may have even larger fractions of high-ability personnel than shown in the next section.

Bonus Method. The bonus method tested here assumes a cash bonus offered to high-ability recruits entering some subset of Army jobs, and assumes that recruits view this cash bonus as a pay increment. Given a wage elasticity ϵ , the change in enlistees' perceived first-term earnings (ΔE) necessary to attract ΔH additional high-ability recruits is given by:

$$\frac{H + \Delta H}{H} = \left(\frac{E + \Delta E}{E} \right)^\epsilon, \quad (6)$$

where H = total number of high-ability Army male recruits for FY81, given old standards, and E = present value of average perceived three-year enlisted earnings, FY81. Let H' denote the number of Infantry high-ability recruits, given old standards, and $\Delta H'$ the increment to that number given the new ability mix. Solving Eq. (6) for ΔE , multiplying it by $(H' + \Delta H')$ (the number of Infantrymen who will receive the bonus), and adding in existing variable recruiting costs in FY81 (C_A') yields:

$$C_A = (H' + \Delta H') E [(1 + \Delta H/H)^{1/\epsilon} - 1] + C_A'. \quad (7)$$

Several studies have shown that the wage elasticity of high-ability supply for the Army is at or above 1.0 (e.g., Huck and Allen, 1977; Haggstrom et al., 1980). The assumption here is that $\epsilon = 1.0$, and for a conservative sensitivity test, results are also presented for $\epsilon = 0.8$. Based on recent history, the number of high-ability males entering the Army in fiscal 1981 (H) is estimated at 25,000, and perceived discounted three-year wages of first-term enlistees (E) is estimated at \$20,800. This perceived-wages figure is less than actual pay, reflecting both discounting of future pay and survey results showing that enlistees generally estimate their wages to be about three-fourths of actual pay and cash allowances. The number of high-ability recruits in the Infantry (H'), given pre-1981 enlistment standards, would be about 2500. The increment to Infantry high-ability recruits ($\Delta H'$) depends upon the specific ability mix being tested. The increment to total high-ability recruits for the Army as a whole (ΔH) depends upon the number of jobs included in the high-ability bonus. We assume a bonus option offered for all Army combat arms jobs. Recent data show that combat arms jobs absorb about 40 percent of all high-ability recruits, yielding 10,000 men receiving the hypothetical bonus out of the present total of 25,000 high-ability recruits. Since this is four times the number of high-ability recruits in the Infantry, the estimate $\Delta H = 4\Delta H'$ is used for all new ability mixes. Finally, current recruiting expenditures show an average variable cost of about \$6000 per high-ability recruit, for a total existing variable cost of recruiting in the Infantry (assuming no change in high-ability recruits) of \$15.4 million (C_A').

Given these various estimates and assumptions, the marginal cost of recruiting one additional high-ability Infantryman ($\Delta H' = 1$) is

Assumption A: \$8,323 ($\epsilon = 1.0$)

Assumption B: 10,404 ($\epsilon = 0.8$)

As Infantry aptitude standards are altered by the model, raising the number of high-ability recruits, the marginal cost will rise because of the assumption of constant elasticity.

Recruiter Method. If additional high-ability men are attracted through an increase in the size of the recruiting force, the total variable cost of recruiting Infantrymen is given by:

$$C_A = 1/4 V R [(1 + \Delta H/H)^{\eta} - 1] + C_A', \quad (8)$$

where η is the elasticity of high-ability supply with respect to the number of recruiters, R is the existing number of recruiters, V is the average variable cost of a single recruiter in 1981 dollars, and the other terms are as defined in Eq. (6). The fraction 1/4 means that one-fourth of the additional high-ability recruits in the Army enter the Infantry.

Based on the study by Huck and Allen (1977), the estimate $\eta = 0.33$ is used for Army recruiters; based on current Army data, the estimates $R = 4613$ and $V = \$37,210$ are adopted. Given these assumptions, the cost of recruiting one additional high-ability man into the Infantry is

Assumption C: \$20,809 ($\eta = 0.33$)

Again, a constant elasticity is assumed as the number of recruiters increases.

Total Recruiting Costs

The total variable cost of recruiting, as a function of the number of high-ability recruits, is plotted in Fig. 10. At baseline, assuming no changes in ability mix, the total variable cost of recruiting 2500 high-ability men in the Infantry is estimated at about \$15.4 million. Under assumption A, a \$5000 bonus for a regular three-year enlistment in selected jobs would bring about 1500 additional high-ability recruits into the Infantry (and 6000 into all selected Army jobs), for a total additional Infantry cost of \$20 million (\$80 million for total Army).⁶ In order to double the number of high-ability men in the Infantry (10,000 increase for total Army), a bonus of \$8300 would have to be offered under assumption A, for total additional Infantry recruiting costs of about \$41 million, and \$166 million for the total Army.

Costs for the recruiter method are also plotted in Fig. 10 (Assumption C). Note that increasing the number of high-ability recruits by adding recruiters is more costly for the Infantry than using bonuses, given our assumptions. By the recruiter method, adding 1500 high-ability recruits to the Infantry would result in total variable recruiting costs of \$55 million, compared with \$36 million by the bonus method. Each of the 1500 additional recruits would add an average of \$26,400 to total variable recruiting costs under the recruiter method, but only \$13,600 under the bonus method. Therefore, if these elasticity estimates and other assumptions hold for today's Army, the bonus method is a more cost-effective means than the recruiter method for increasing the supply of high-ability men. It is still useful to investigate all three recruiting cost assumptions, however, because they will illustrate the sensitivity of the cost-performance model to fairly substantial differences in recruiting cost assumptions.

⁶Total additional cost is $\$5000 \times (1500 + 2500)$. The bonus must be paid to all high-ability Infantrymen, not merely the 1500 additional.

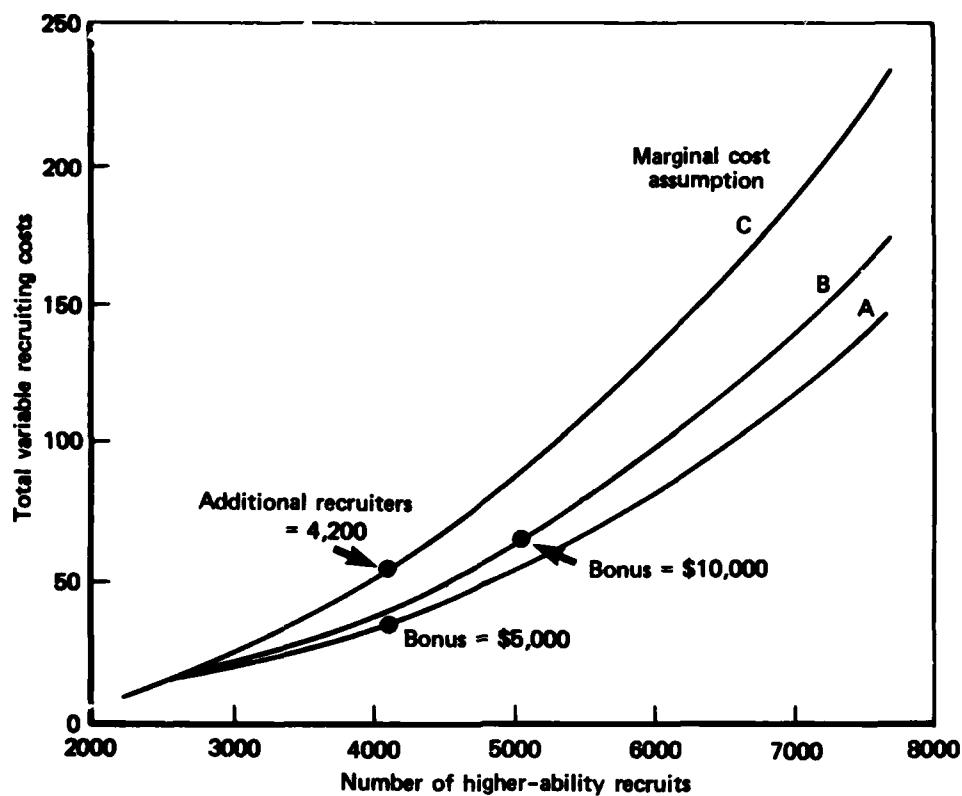


Fig. 10—Estimated cost of higher-ability Infantry recruits

Cost of Training and Force Maintenance

The estimates for the cost of training and force maintenance were provided to this project by OASD(MRA&L). The cost estimates are based on Army budget figures, separated into fixed and variable components, and on current pay and allowance tables. All costs are calculated in 1981 dollars.⁷

The total variable cost of basic training is given by

$$C_B = c_B A, \quad (9)$$

where c_B is the per capita cost of basic training and A is the number of accessions. This per capita cost includes pay and allowances, assuming two months for initial processing and basic training; costs for uniform, equipment, and travel to the training site; variable portions of training instructors and base support; and an average separation cost (which will be incurred for most accessions by the end of the first three or four years).

Variable cost of advanced training is given by

$$C_T = c_T A \sum_i (P_i B_i), \quad (10)$$

⁷Since the performance and cost models are applied to three years of service (e.g., 1981 to 1983), changes in actual P and A and base support expenses are assumed to reflect inflation adjustments rather than changes in real dollars.

where c_T is the per capita cost of advanced training and the other terms are as defined in Eq. (1).⁸ The per capita cost includes pay and allowance for three months, covering not only the training period but also post-training leave and travel time to reach the first duty station. It also includes travel costs, equipment costs, and the variable portions of instructor and base support costs.

The cost of maintaining the Infantry force after training and through the first term is given by

$$C_1 = A \sum_i [P_i B_i T_i \sum_t (c_{Rt} R_t)], \quad (11)$$

where c_{Rt} is the per capita force cost from the 6th to the 36th month of service and the other terms are as defined in Eq. (1). The components of c_{Rt} are average pay and allowances for a given month of service, travel, and the variable portion of base support costs (assumed constant for all months). The per capita cost is dependent on time because average pay and allowances increase as the average grade increases over time.⁹

Estimates of variable training and force maintenance costs for Army Infantry (in 1981 dollars) are shown in Fig. 11. Combined per capita basic and advanced training costs (variable portion) are estimated at about \$7700, with \$3000 being attributable to basic training. Post-training force costs start at about \$7500 per person for the first six months on the job and increase to about \$8300 for the last six months of the three-year enlistment period. This reflects an increase in the average grade from E2 at the end of training to E4 at the end of three years.

The cost estimates in this report are preliminary. In particular, they rest on assumptions about recruiting costs (discussed above) that should receive further investigation. The cost results presented in the following sections are therefore illustrative only and are subject to revision.

⁸In the current model, per capita advanced training costs are assumed identical for all individuals, but the model can be modified to compute these costs within ability categories if further investigations reveal significantly higher training costs for persons of lower ability.

⁹The average cost is determined by establishing the pay and allowance (plus base support costs) for each grade, and then computing a weighted average for each time interval according to the distribution of grades at that time.

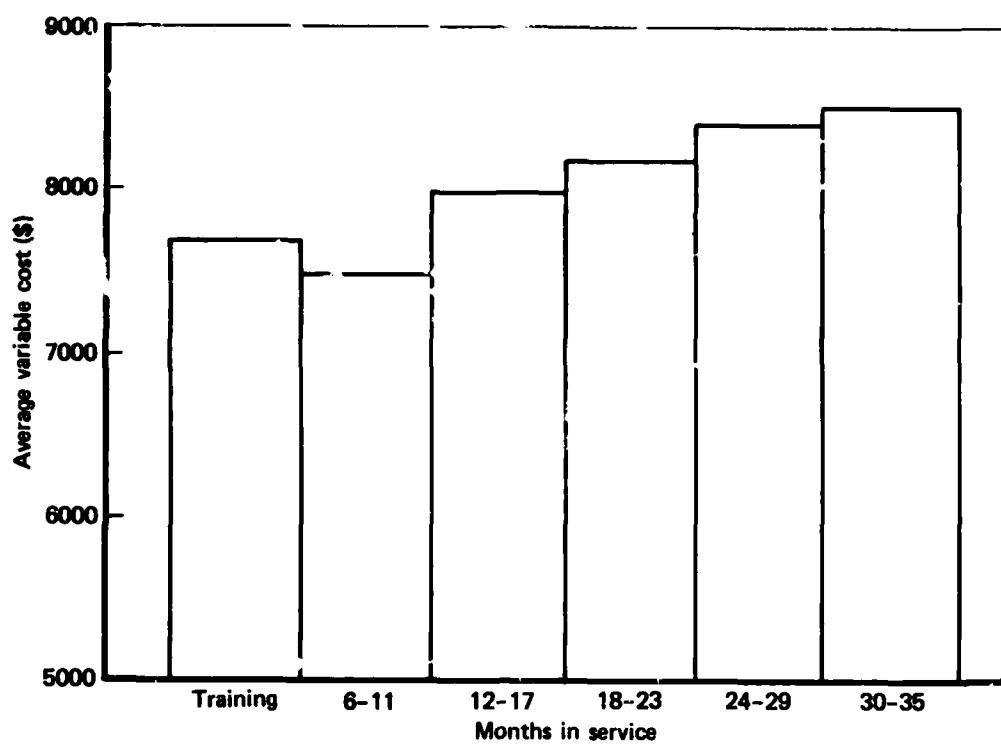


Fig. 11—Estimated average variable costs of training and duty time for first-term Army Infantrymen

IV. ENLISTMENT STANDARDS FOR THE INFANTRY

The cost-performance model and the force-cost estimates described in Sec. III enable investigation of optimal enlistment ability standards for the Army Infantry. By optimal is meant ability mixes that minimize cost for a given level of Infantry performance, both with respect to attrition and on-the-job effectiveness. If optimal ability mixes can be found, two important policy questions follow: (1) Do the optimal mixes imply higher ability standards for the Army Infantry, and if so, (2) how much will these higher standards cost? This last question depends in large measure on the recruiting cost assumptions described in the previous section.

It should be reemphasized that while Sec. II documents a strong relationship between entry aptitudes and on-the-job performance, the cost-performance model described in Sec. III will not necessarily yield an optimum aptitude standard higher than the pre-1981 standard. The reason is that higher-aptitude recruits cost more to attract into the Army than low-aptitude recruits. Therefore, an optimal aptitude standard depends upon the trade-off between the more costly but better-performing higher-ability recruits versus the less costly but poorer-performing low-ability recruits.

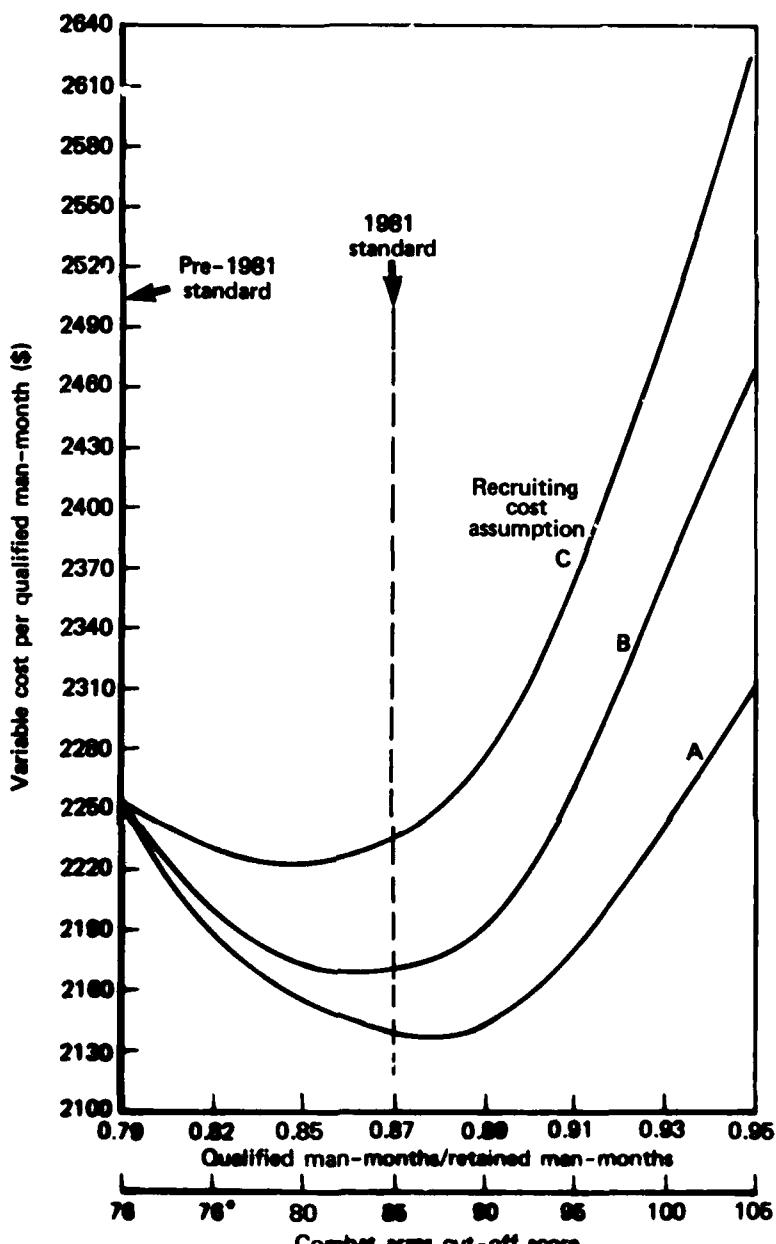
OPTIMAL APTITUDE LEVELS

The criterion used to investigate optimal standards is variable force cost per qualified man-month.¹ This unit cost is derived for a given ability mix by dividing variable force cost (C) by qualified man-months (Q). The value of this criterion is computed for ability mixes obtained as the cut-off for the Combat Arms aptitude score varies from 76 to 105, under the proportionality assumption given by Eq. (4) and the additional constraint of no category IV nongraduates. The changes in AFQT categories and high school status for varying Combat Arms cut-off scores were shown above (Fig. 9).

Cost per qualified man-month for differing Combat Arms aptitude cut-offs is shown in Fig. 12 for each of the three recruiting cost assumptions. There are several significant features of these relationships. First, and most important, the cost-performance model can show optimal aptitude cut-offs, which are those points where the cost per qualified man-month reaches a minimum. These are also optimal points in the sense of minimizing cost for a given number of qualified man-months. Moreover, for all three cost assumptions, the optimum point is well above the pre-1981 cut-off score of 76 on the Combat Arms aptitude test, even though all category IV nongraduates are eliminated. For cost assumption A, the optimum cut-off would be about 87, which just about corresponds to the cut-off being used for Infantry-men in 1981 (85), and for cost assumption C the optimum cut-off is about 80.

Interestingly, the optimal ability cut-off spans a fairly narrow range in spite of substantially different recruiting cost assumptions. For an additional 1500 high-ability men, the recruiting cost assumptions range from \$13,600 to \$26,400 per additional recruit, and yet the

¹This criterion reflects this study's interest in optimal aptitude standards independent of force size. The standard that minimizes this criterion is not strictly constant for different force sizes, although it is approximately so over the ranges of force sizes considered. See App. C for an explanation and for an alternate method of determining optimal standards for differing total force sizes.



*Excluding category IV non-graduates.

Fig. 12—Cost per qualified man-month for differing standards

difference in the optimal Combat Arms cut-off scores ranges only from 87 to 80, respectively. For the Infantry, then, it appears that the optimal aptitude cut-off score is fairly robust under quite different recruiting cost assumptions. Therefore, it is likely that the Army's new standard of 85 for Infantryman comes fairly close to a cost-effective level under the cost assumptions made here.

COST OF DIFFERING STANDARDS

Although Fig. 12 shows a minimum-cost value for ability standards considerably higher than the pre-1981 standard, this does not mean that raising ability standards in the Army will produce cost savings. It implies only that one obtains the most cost-effective force in terms of dollars spent per qualified man-month. Since Army policy retains nonqualified men in order to meet manpower requirements, raising ability standards while maintaining existing manning levels will cause an increase in overall force costs in the form of higher recruiting costs.

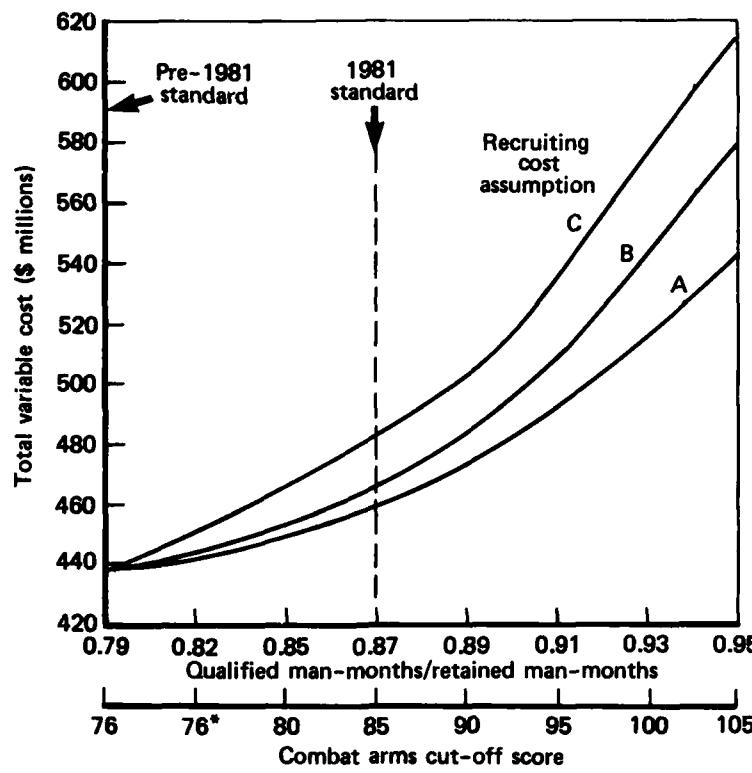
Figure 13 shows the increasing costs for raising Infantry aptitude standards. All of this increased cost comes from recruiting expenditures. Under recruiting cost assumption A, at the optimum point of 85 the increased cost is about \$23 million for about 1750 additional high-ability recruits, which will yield an additional 600 qualified Infantrymen. This 5 percent increase in total variable force-costs for the Infantryman specialty would yield approximately a 10 percent increase in the number of working-months contributed by enlistees who meet the minimum job performance standard. Under recruiting cost assumptions B and C, the additional costs would be \$32 and \$45 million, respectively.

We emphasize that these recruiting cost figures reflect only Infantry costs. The recruiting costs were derived by assuming that the Army as a whole would recruit about four times as many high-ability men as the Infantry. Therefore, under assumption A, total Army recruiting costs would rise by about \$92 million annually for an additional 7000 high-ability recruits (cut-off of 85). Under assumptions B and C the additional recruiting costs would be \$128 and \$180 million, respectively. The number of qualified persons obtained for other jobs depends upon the relationship between aptitude and SQT results for those particular jobs. However, given the similarity of the relationship between ability and job performance in five Army jobs including Infantry, as shown in Fig. 7, it is reasonable to expect similar cost-performance results for other jobs.

ALTERNATIVE ABILITY MIXES

The optimal ability mix resulting from a cut-off score of 85 on the Combat Arms test can be subjected to additional constraints involving AFQT and high school status. The ability mix used in Fig. 12 is derived from the proportionality assumption specified in Eq. (4), and the additional constraint of no category IV nongraduates. There may be other ability mixes of interest to policymakers, corresponding to specific limits on the proportion of category IV or nongraduate recruits. Such specialized ability mixes may be more or less cost-effective than the ability mix presumed in Fig. 12.

Figure 14 compares three ability mixes. The left-hand side of the figure shows the ability mix resulting from the pre-1981 ability standards (that is, prior to the corrected test norms). This shows that about 25 percent of recent Infantry recruits were category IV nongraduates,



*Excluding category IV non-graduates.

Fig. 13—Total costs for differing standards

who were not eligible for enlistment and who were enlisted only because of the test errors. At the same time, only about 21 percent were category I to IIIA high school graduates, the group viewed as most desirable throughout the military services.

The ability mix in the center of Fig. 14 is derived from the cut-off of 85 generated by the model in Fig. 12 (cost assumption A).² Note that with a Combat Arms cut-off score of 85, the proportion of category I to IIIA high school graduates rises to about 37 percent and the proportion of category I to IIIA nongraduates also rises from 12 to 20 percent; the proportion of category IV recruits drops to 18 percent.

The reasons why this ability mix maximizes cost-effectiveness can be understood more easily by considering the cost-effectiveness (cost per qualified man-month) of specific ability groups.³ First, category IV graduates are the least cost-effective, with cost per qualified man-month at \$2601. High-ability graduates are far more cost-effective, even though they cost a great deal more to recruit; at a cut-off of 85, category I and II graduates have a cost per qualified man-month of \$2202, and category IIIA graduates have a cost of \$2370.

²The computer simulation chooses cut-offs in 5-point intervals, so 85, comes closest to the actual optimal cut-off of 87 for cost assumption A.

³See App. A, page 3 on computer print-out, for a listing of cost per qualified man-month for all ability groups in alternative mixes.

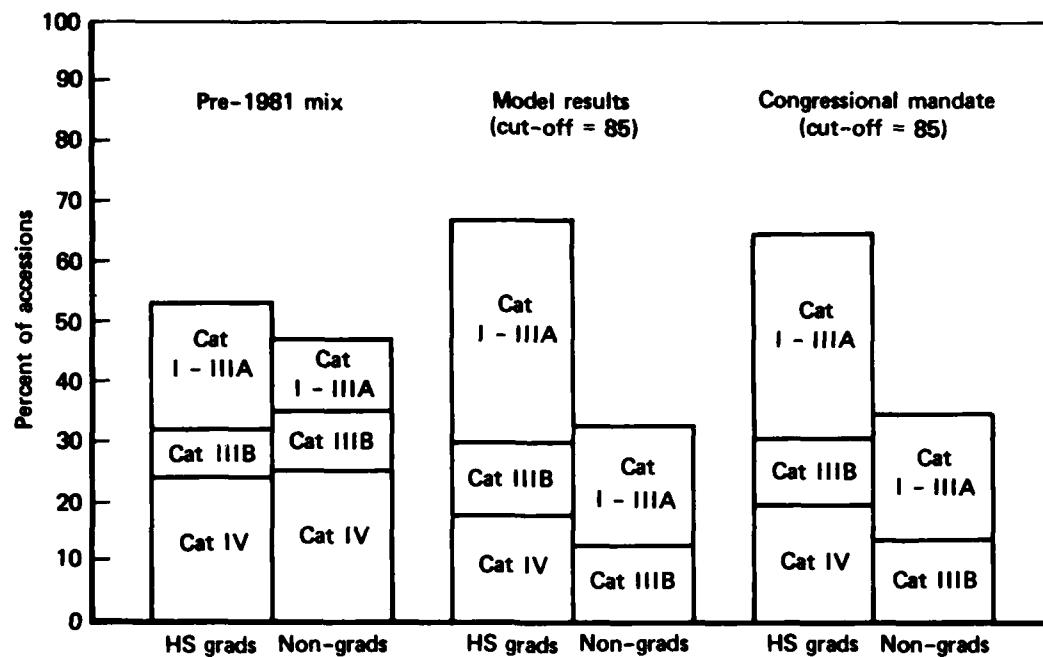


Fig. 14—Alternative ability mixes compared to current mix

Second, category IV graduates are somewhat less cost-effective than category I-III A non-graduates, under the assumption that neither group requires extra recruiting costs. Category IV graduates have a cost of \$2358 per qualified man-month, compared with \$2016 for category I-III A nongraduates.⁴ Although high-aptitude nongraduates have high attrition, those who stay demonstrate better performance, outweighing the high retention but poorer performance of low-aptitude graduates.

The ability mix shown on the right-hand side of Fig. 14 is the one generated by the ultimate Congressional mandate (1983 and beyond), applied to the Infantry with a cut-off of 85. This mandate requires that each service recruit no more than 35 percent nongraduates and no more than 20 percent category IV overall. Although specific jobs within the Army may depart from this standard, it is applied here to the Infantry for illustrative purposes.

There is virtually no difference between the mix derived from the Congressional mandate and the optimal result from the Infantry model. Thus, under the assumptions made here, the Congressional restrictions on ability-levels yield a significantly more cost-effective Infantry force than the pre-1981 Army standards. The similarity between the model result and the mix derived from the Congressional mandate will only occur, however, if the latter mix is applied to a selected number of MOSs (any subgroup currently enlisting about 40 percent of category I-III A graduates). If the Congressional mandate were applied to all Army jobs, recruiting costs would rise and the cost-optimal ability mix would yield somewhat fewer high-ability personnel.

⁴These are values assuming the pre-1981 ability mix. With a cut-score at 85, the values become \$2146 and \$1978, respectively, so that even with the 1981 standards high-aptitude nongraduates are more cost-effective than low-aptitude graduates.

Specifically, under the Congressional mandate applied to all jobs, the number of additional high-ability recruits would probably rise to 10,000 or 12,000 if the mandate were met. Under cost assumption A this could mean an average bonus of \$8,000 to \$10,000 and total additional costs ranging from \$280 million to \$370 million. This would not be an optimal solution under the present model; bonuses that high would drop the cost-optimal cut-score for Infantry back to 80 or so (and thereby reduce the number of high-ability recruits back to about 7000). This cut-off would result in about 30 percent category I-III A graduates, 25 percent category IV graduates, and 31 percent nongraduates. Of course, even this ability mix is substantially higher in quality than the pre-1981 mix, given the exclusion of category IV nongraduates.

V. CONCLUSION

The aptitude standards used between 1976 and 1980 in conjunction with the miscalibrated ASVAB led to the enlistment of large numbers of low-aptitude personnel, many of whom would not have qualified had those same standards been applied to correct test scores. Compared with other services, the Army had the largest influx of low-aptitude recruits, comprising fully one-half of all Army recruits during this period. These low-aptitude recruits, called "category IV," are below the 30th percentile in general aptitude, compared with a group that would approximately represent the U.S. youth population.

Although this decline in aptitude is cause for concern, it does not by itself indicate whether and by how much actual job performance has been affected. This has been a much-debated issue in military manpower circles, largely because the military has many low- and moderately-skilled jobs, particularly in the combat areas. Some analysts have argued that aptitude levels have little to do with performance in these types of jobs.

The data presented here contradict the view that recruit aptitude is unimportant. Using two different types of on-the-job performance tests, and five different Army jobs, it has been shown that lower-aptitude recruits have significantly lower job-proficiency scores, and are significantly less likely to meet minimum proficiency standards than are higher-aptitude personnel. Therefore, the decline in ability standards in recent years has lowered Army manpower effectiveness by enlisting more personnel who are unable to meet minimum skill requirements.

From the relationship between aptitudes and job performance alone, higher ability standards in the Army would clearly be desirable, subject to constraints imposed by other manpower policies. In fact, the Army has already raised its standards starting in October 1980, although the standards are still somewhat lower than those in effect during the draft years. The key policy question then becomes whether these revised standards provide for a cost-effective manpower force. This study has attempted to answer this final question by developing a methodology for determining "optimal" ability mixes according to cost-effectiveness criteria.

The central component of this methodology is a cost-performance model that compares the total variable cost of recruiting and maintaining a first-term force for forces of varying ability mixes. The ability mix varies according to AFQT distribution, high school status, and the aptitude score cut-off for eligibility for a given job. The model computes the number of qualified man-months, defined as the number of months contributed by persons who complete training, remain in the Army, and can pass an on-the-job Skill Qualification Test. By attaching a cost to this number of qualified man-months, different ability mixes can be compared for cost-effectiveness, defined as the cost of producing a given level of qualified man-months.

The results for Army Infantrymen show that the model can generate a series of optimum ability mixes for various recruiting cost assumptions. Generally speaking, the model shows that optimum ability mixes require higher ability standards than those used between 1976 and 1980. Moreover, the standards mandated by Congress for the 1982 fiscal year, when applied to the Infantry, also generate a more cost-effective ability mix than pre-1981 standards. The Congressional mandate ultimately calls for a maximum of 20 percent category IV personnel and 35 percent non-high-school graduates.

Assuming that present manning levels remain constant, raising ability standards will

increase recruiting costs substantially. Although the recruiting cost estimates need further refinement, preliminary estimates based on the Infantry specialty suggest that optimum ability mixes might cost the Army between \$100 to \$200 million per year in extra recruiting costs, either in the form of additional recruiters or in the form of enlistment bonuses or other enlistment incentives. Such expenditures would deliver only 7,000 additional high-ability men, out of an estimated 105,000 Army non-prior-service male accessions in 1981. If the Congressional mandate were applied to all Army jobs, this increment could rise to 10,000 or 12,000 high-ability recruits (or more) at an increased cost on the order of \$280 million to \$370 million per year. Moreover, as the number of 18-year-olds in the general population declines throughout the 1980's, coupled with plans to increase the size of the Army, the competition for high-ability personnel may become even more intense. Recruiting costs may then have to rise even further to attract enough persons to meet these new ability standards.

Notwithstanding these seemingly high costs, this study has shown that higher ability standards make sense. Two points must be kept in mind. First, the additional costs are only a small increment to the total cost of recruiting and maintaining the first-term force; in the Infantry example examined here, achieving the optimal ability mix requires only about a 5 percent increase in total force costs. Second, the return to these additional expenditures is a substantially more capable force; the optimal mix would yield 10 percent more working-months contributed by Infantrymen who are able to meet the minimum job performance standard. Higher standards ensure that more of the Army's recruits are able to perform their jobs adequately, reduce the cost of obtaining each month of qualified job performance, and thereby may justify the costs they impose.

Appendix A

COMPUTER MODEL OUTPUT

This appendix displays the complete output from a single request with selected options as indicated in the output.

CONTENTS

Assumptions, options selected, and ability proportions	34
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11B MC.EL: RETAINED MAN-MONTHS HELD CONSTANT
ACCESSIONS ASSUMED FOR BASELINE: 12168.

COST ASSUMPTIONS AND OPTION APPLIED

METHOD OF COMPUTING RECRUITING COST:
ELASTICITY USED FOR RECRUITING COST:
ESTIMATED NUMBER OF I-IIIA HS GRADS:
MULTIPLIER FOR I-IIIA HS GRADS:
PFR CAPITA RECRUITING COST FOR I-IIIA HS GRADS:
NUMBER OF RECRUITERS:
PER CAPITA VARIABLE COST PER RECRUITER:
PER CAPITA COSTS OF FORCE TRAINING AND MAINTENANCE:

BASIC TRAINING	BONUS
ADVANCED TRAINING	\$ 3096
ACTIVE DUTY; 6-11 MONTHS	\$ 4446
ACTIVE DUTY; 12-17 MONTHS	\$ 7416
ACTIVE DUTY; 18-23 MONTHS	\$ 8034
ACTIVE DUTY; 24-29 MONTHS	\$ 8240
ACTIVE DUTY; 30-34 MONTHS	\$ 8454
PROPORTION(S) ALLOWED FOR APTITUDE	\$ 8508
SCORES 70-75	0.150

THE FOLLOWING MARGINAL PROPORTIONS HAVE BEEN SELECTED:

0% OF THE DISTRIBUTION WILL BE NHS AFQT IV

CURRENT ABILITY PROPORTIONS AT BASELINE (CUT-SCORE 76+)

	I-II	IIIA	IIIB	IV
HS	0.14594996	0.06561136	0.08367717	0.23870933
NHS	0.06504673	0.05778121	0.09305376	0.25017214

ABILITY PROPORTIONS AT BASELINE AFTER FIXED MARGINALS APPLIED

	I-II	IIIA	IIIB	IV
HS	0.19461391	0.08750153	0.11159480	0.31835157
NHS	0.08674842	0.0705891	0.12409973	0.0

MODEL: RETAINED MAN-MONTHS HELD CONSTANT

ACCESSIONS ADJUSTED TO FIXED MARGINALS

RETAINED MAN-MONTHS HAS A CONSTANT VALUE OF 247116. IN THIS SET OF TABLES

APTITUDE AREA CUT-SCORE	NUMBER OF ACCESSIONS	HS GRADS I-III-A		NON-HS I-III-A		HS GRADS I-III-B-IV		NON-HS I-III-B-IV		STARTING TRAINING	RETAINED MAN-MONTHS	QUALIFIED MAN-MONTHS	NON-QUALIFIED MAN-MONTHS
		115+	110+	112+	111+	110+	105+	100+	95+	90+	85+	80+	75+
115+	11242.	8513.	2309.	257.	163.	10503.	247116.	240320.	247116.	247116.	247116.	247116.	6795.
110+	11331.	7796.	2689.	495.	351.	10515.	247116.	237387.	247116.	247116.	247116.	247116.	9729.
105+	11510.	7066.	2917.	861.	666.	10629.	247116.	234028.	247116.	247116.	247116.	247116.	13088.
100+	11644.	6434.	2930.	1346.	916.	10723.	247116.	230531.	247116.	247116.	247116.	247116.	16584.
95+	11757.	5547.	2822.	2108.	1280.	10793.	247116.	225368.	247116.	247116.	247116.	247116.	21767.
90+	11756.	4732.	2572.	2965.	1487.	10713.	247116.	219389.	247116.	247116.	247116.	247116.	21727.
85+	11728.	4331.	2404.	3475.	1519.	10742.	247116.	215562.	247116.	247116.	247116.	247116.	31553.
80+	11651.	3747.	2144.	4222.	1507.	10666.	247116.	208968.	247116.	247116.	247116.	247116.	38147.
75+	11580.	3267.	1897.	4979.	1437.	10620.	247116.	202031.	247116.	247116.	247116.	247116.	40985.
70+	11523.	2905.	1709.	5529.	1384.	10547.	247116.	193619.	247116.	247116.	247116.	247116.	53196.
BASELINE	12168.	2574.	1495.	3923.	4176.	10976.	247115.	194677.	247115.	247115.	247115.	247115.	52438.

APTITUDE AREA CUT-SCORE	PROPOR. OF BASELINE ACCESSIONS	PROPORTION OF ACCESSIONS				STARTING TRAINING	RETAINED MAN-MONTHS	PROPORTION OF BASELINE			
		HS GRADS I-III-A	NON-HS I-III-A	HS GRADS I-III-B-IV	NON-HS I-III-B-IV			QUALIFIED MAN-MONTHS	NON-QUALIFIED MAN-MONTHS		
115+	0.9239	0.7572	0.2054	0.0229	0.0145	0.9569	1.0000	1.2345	0.1296		
110+	0.9112	0.6880	0.2313	0.0437	0.0310	0.9581	1.0000	1.2194	0.1855		
105+	0.9459	0.6139	0.2544	0.0748	0.0579	0.9684	1.0000	1.2021	0.2021		
100+	0.9569	0.5296	0.2517	0.1171	0.0796	0.9770	1.0000	1.1842	0.3163		
95+	0.9662	0.4718	0.2400	0.1793	0.1089	0.9834	1.0000	1.1576	0.4147		
90+	0.9662	0.4025	0.2186	0.2522	0.1265	0.9816	1.0000	1.1269	0.5288		
85+	0.9638	0.3593	0.2059	0.2963	0.1295	0.9787	1.0000	1.1073	0.6017		
80+	0.9272	0.3216	0.1810	0.3620	0.1224	0.9718	1.0000	1.0734	0.7212		
75+	0.9517	0.2221	0.1638	0.4299	0.1241	0.9558	1.0000	1.0378	0.8538		
70+	0.9470	0.2518	0.1483	0.4798	0.1201	0.9609	1.0000	0.9946	1.0202		

COSTS IN THOUSANDS OF DOLLARS

APTITUDE AREA CUT-SCORE	COST OF RECRUITS	BASIC TRAINING		TRAINING SCHOOL	RETAINED MAN-MONTHS	TOTALS	NON-QUALIFIED MAN-MONTHS	COST PER ACCESSION	QUALIFIED MAN-MONTHS	COST PER QUALIFIED MAN-MONTH	
		115+	110+	105+	100+	95+	90+	85+	80+	75+	70+
115+	183706.6	34806.5	48796.6	330221.6	601531.1	9148.4	53506.	2137624	2563.		
110+	15022.2	35633.8	48854.8	33481.4	56908.5	13096.2	50221.	2095058	2337.		
105+	12056.1	36048.9	49380.8	33437.8	540208.5	17616.8	46935.	2013322	2308.		
100+	98083.5	36319.8	49819.3	33420.7	518012.4	22324.7	44494.	1919878	2217.		
95+	70319.5	36398.4	50145.9	33403.7	490967.7	29278.9	41761.	1916954	2179.		
90+	19916.4	36397.5	50052.1	33415.6	470001.6	37340.6	39979.	1866136	2112.		
85+	40161.6	36309.9	49905.6	33434.5	46111.6	42504.0	39317.	1838013	2139.		
80+	30011.8	36010.7	49553.1	33417.2	449286.7	51406.7	38613.	1793602	2153.		
75+	22980.7	32821.8	49246.4	334213.1	442223.9	60776.4	38194.	1744644	2189.		
70+	18610.4	35674.3	49001.4	334243.6	437529.6	72143.6	37971.	1680328	2260.		
BASELINE	15445.7	37672.	50992.8	334032.6	438143.2	70641.7	36018.	15.99914	2251.		

116 MODEL: RETAINED "MONTHS HELD CONSTANT
NUMBER" OF RETAINED AND QUALIFIED MEN AT THE END OF EACH TIME INTERVAL

APTITUDE AREA CUT-SCORE	6-11	MONTHS IN SERVICE				30-34
		12-17	18-23	24-29		
15+	QUALIFIED RETAINED	90 ²⁶ 9318.	8337. 8586.	7878. 6097.	7529. 7724.	7283. 7459.
	QUALIFIED RETAINED	8927. 8615.	8285. 8103.	7788. 7697.	7420. 7302.	7174. 7059.
105+	QUALIFIED RETAINED	8812. 9377.	8151. 8616.	7681. 8105.	7302. 76.	7425. 7395.
100+	QUALIFIED RETAINED	8676. 9390.	8032. 8646.	7570. 8107.	7191. 7663.	6954. 7380.
95+	QUALIFIED RETAINED	8468. 9400.	7852. 8651.	7405. 8110.	7033. 7654.	6804. 7366.
90+	QUALIFIED RETAINED	8209. 9387.	7636. 8659.	7214. 8115.	6861. 7657.	6646. 7369.
85+	QUALIFIED RETAINED	8040. 9371.	7445. 8657.	7092. 8118.	6753. 7663.	6549. 7377.
80+	QUALIFIED RETAINED	7748. 9340.	7252. 8652.	6880. 8124.	6568. 7677.	6381. 7395.
76+	QUALIFIED RETAINED	44. 9304.	49. 8644.	6996. 8129.	6557. 7694.	6373. 7418.
70+	QUALIFIED RETAINED	7095. 9276.	6650. 8618.	6383. 8133.	6127. 7707.	5978. 7434.
81* SELINE	QUALIFIED RETAINED	7246. 9454.	6765. 8634.	6408. 8115.	6105. 7621.	5923. 7303.

PROPORTION OF RETAINED MEN WHO ARE QUALIFIED: PROPORTION OF RETAINED MAN-MONTHS THAT ARE QUALIFIED

APTITUDE AREA CUT-SCORE	6-11	MONTHS IN SERVICE				TOTAL QMNM/RMM
		12-17	18-23	24-29	30-34	
115+	0.9687	0.9708	0.9729	0.9748	0.9764	0.9725
110+	0.9552	0.9571	0.9612	0.9640	0.9662	0.9606
105+	0.9398	0.9433	0.9478	0.9515	0.9545	0.9470
100+	0.9240	0.9290	0.9338	0.9384	0.9422	0.9329
95+	0.9008	0.9070	0.9131	0.9189	0.9237	0.9120
90+	0.8745	0.8818	0.8890	0.8960	0.9019	0.8878
85+	0.8579	0.8657	0.8736	0.8812	0.8877	0.8723
80+	0.8296	0.8382	0.8470	0.8555	0.8629	0.8456
76+	0.8001	0.8093	0.8189	0.8282	0.8365	0.8176
70+	0.7646	0.7745	0.7848	0.7949	0.8011	0.7835
BASELINE	0.7664	0.7762	0.7897	0.8011	0.8110	0.7878

11B MODEL: RETAINED MAN-MONTHS HELD CONSTANT
COST PER RECRUIT, QUALIFIED MAN-MONTHS PER RECRUIT AND COST PER QUALIFIED MAN-MONTH.

APTITUDE AREA CUT-SCORE	ABILITY PROPORTIONS	COST PER RECRUIT				QUALIFIED MAN-MONTHS PER RECRUIT				COST PER QUALIFIED MAN-MONTH						
		I-11	IIIA	IIIB	IV	I-11	IIIA	IIIB	IV	I-11	IIIA	IIIB	IV			
115+	HS 0.713 NHS 0.178	0.445 0.027	0.016 0.014	0.006 0.0	\$ 60044. 303358.	58976. 30167.	38615. 30519.	38058. 30708.	22.35 18.66	21.31 16.17	22.01 16.30	21.24 16.16	\$ 2687. 1788.	2768. 1866.	1754. 1872.	1792. 1900.
110+	HS 0.615 NHS 0.188	0.073 0.049	0.031 0.031	0.013 0.0	\$ 57922. 33283.	56972. 30892.	38655. 31305.	38094. 31254.	22.27 18.41	21.13 16.32	21.76 16.40	20.81 16.07	\$ 2601. 1808.	2696. 1893.	1786. 1908.	1831. 1945.
105+	HS 0.515 NHS 0.182	0.98 0.072	0.051 0.058	0.024 0.0	\$ 55730. 32794.	54801. 30479.	38912. 30781.	37973. 30685.	22.15 17.89	20.87 15.73	21.40 15.65	20.32 15.15	\$ 2516. 1833.	2626. 1937.	1819. 1967.	1869. 2026.
100+	HS 0.419 NHS 0.168	0.114 0.064	0.072 0.079	0.045 0.0	\$ 52612. 32495.	52816. 30178.	38771. 30426.	37783. 30208.	22.03 17.54	20.53 15.27	20.90 15.07	19.59 14.31	\$ 2443. 1853.	2573. 1977.	1855. 2020.	1928. 2110.
95+	HS 0.357 NHS 0.146	0.115 0.094	0.096 0.109	0.083 0.0	\$ 51223. 32342.	50200. 30085.	38700. 30347.	37729. 30196.	21.91 17.28	20.21 14.87	20.37 14.54	18.86 13.67	\$ 2338. 1872.	2483. 2023.	1904. 2087.	2000. 2208.
90+	HS 0.292 NHS 0.124	0.111 0.095	0.111 0.127	0.141 0.0	\$ 49000. 32286.	48007. 30104.	38782. 30405.	37940. 30337.	21.82 17.11	19.96 14.60	19.98 14.17	18.19 13.12	\$ 2245. 1887.	2405. 2062.	1941. 2145.	2086. 2312.
85+	HS 0.262 NHS 0.111	0.107 0.091	0.115 0.130	0.182 0.0	\$ 47969. 32270.	46986. 30109.	38806. 30421.	38013. 30381.	21.76 17.03	19.82 14.46	19.75 13.98	17.71 12.77	\$ 2202. 1895.	2370. 2082.	1965. 2177.	2146. 2378.
80+	HS 0.225 NHS 0.099	0.097 0.085	0.115 0.129	0.250 0.0	\$ 46592. 32249.	45633. 30115.	38884. 30437.	38238. 30424.	21.74 16.93	19.66 14.27	19.44 13.67	17.01 12.21	\$ 2143. 1904.	2319. 2111.	2000. 2226.	2249. 2492.
75+	HS 0.195 NHS 0.087	0.088 0.077	0.12 0.124	0.318 0.0	\$ 45601. 32224.	44647. 30020.	38891. 30389.	38282. 30329.	21.70 16.85	19.53 14.11	19.13 13.40	16.23 11.66	\$ 2101. 1912.	2287. 2132.	2033. 2268.	2358. 2601.
70+	HS 0.171 NHS 0.077	0.080 0.071	0.109 0.120	0.371 0.0	\$ 44982. 32211.	44032. 30093.	38897. 30402.	38305. 30378.	21.65 16.75	19.29 13.90	18.65 13.03	15.27 11.01	\$ 2078. 1923.	2283. 2165.	2086. 2333.	2508. 2758.
BASELINE	HS 0.146 NHS 0.065	0.066 0.058	0.084 0.093	0.239 0.250	\$ 4366. 32221.	43614. 30089.	38891. 30389.	38282. 30329.	21.70 -6.85	19.53 14.11	19.13 13.40	16.23 11.66	\$ 2053. 1912.	2234. 2132.	2033. 2268.	2358. 2601.

11B MODEL: RETAINED MAN-MONTHS HELD CONSTANT

BASIC TRAINING PASS RATES

	I	II	IIIA	IIIB	IVA	IVB	IVC
HS	0.95900	0.93600	0.93900	0.93300	0.92700	0.90600	0.92500
NHS	0.94400	0.98700	0.88600	0.100	0.86600	0.85600	0.87500
ADVANCED TRAINING PASS RATES							
115+	110-114	105-109	100-104	95-99	90-94	85-89	80-84
HS	0.94000	0.95000	0.95000	0.94000	0.94000	0.95000	0.95000
NHS	0.90000	0.94000	0.90000	0.86000	0.90000	0.90000	0.90000

POST-TRAINING RETENTION RATES

	MONTHS IN SERV. E			
HS GRAD	6-11	12-17	18-23	24-29
I	0.9700	0.8800	0.8260	0.7960
II	0.9570	0.8940	0.8550	0.8240
IIIA	0.9500	0.8700	0.8160	0.7830
IIIB	0.9540	0.9040	0.8700	0.8380
VA	0.9370	0.8910	0.8500	0.8020
VB	0.9600	0.9170	0.8660	0.8350
VC	0.9540	0.9150	0.8830	0.8570
NHS GRAD	6-11	12-17	18-23	24-29
I	0.9680	0.9360	0.9160	0.9040
II	0.9080	0.9280	0.7430	0.6670
IIIA	0.8840	0.7750	0.6370	0.6230
IIIB	0.9030	0.7990	0.7700	0.6500
VA	0.8990	0.7880	0.730	0.6560
VB	0.9130	0.8060	0.770	0.6610
VC	0.9180	0.8430	0.7950	0.7470

PARAMETERS FOR COMPUTATION OF SQI PERFORMANCE PASS MATES

MOJ:	136.0	126.0	120.0	20.5	26	32.0	104.0	99.5	95.5	91.5	83.0
TOO:				14.0	109.0						
HS:											
ATQT:											
COFF:											
COFFS:											

COFF	ATQT	TCF	MOJ	AFQT
0.52400	0.04166	0.16	-0.29	0.01193

SQT PERFORMANCE PASS RATES		MONTHS IN SERVICE			
HS GRAD	MONTH	12-17	18-23	24-29	30-34
115+	-	0.9776	0.9792	0.9806	0.9819
	-	0.9695	0.9716	0.9735	0.9753
IIIA	-	0.974	0.9603	0.9529	0.9654
IIIB	0.9698	0.9531	0.9562	0.9591	0.9615
IVA	0.9614	0.9452	0.9488	0.9522	0.9551
IVB	0.9111	0.9355	0.9397	0.9436	0.9470
IVC	0.9157	0.9210	0.9261	0.9308	0.9349
110-114	-	0.9645	0.9669	0.9691	0.9712
	-	0.9518	0.9550	0.9580	0.9607
IIIA	0.9132	0.9372	0.9416	0.9454	0.9487
IIIB	0.9216	0.9226	0.9213	0.9257	0.9396
IVA	0.9089	0.9146	0.9200	0.9252	0.9296
IVB	0.8935	0.9001	0.9064	0.9123	0.9174
IVC	0.8706	0.8776	0.8861	0.8931	0.8992
105-109	-	0.9533	0.9564	0.9593	0.9620
	-	0.9368	0.9409	0.9448	0.9484
IIIA	0.9185	0.9185	0.9237	0.9286	0.9328
IIIB	0.8992	0.9046	0.9106	0.9163	0.9212
IVA	0.8822	0.8892	0.8963	0.9028	0.9084
IVB	0.8630	0.8713	0.8791	0.8865	0.8929
IVC	0.8351	0.8447	0.8539	0.8626	0.8702
100-104	-	0.9186	0.9427	0.9465	0.9500
	-	0.9176	0.9229	0.9278	0.9325
IIIA	0.8874	0.8944	0.9010	0.9072	0.9126
IIIB	0.8689	0.8769	0.8844	0.8915	0.8977
IVA	0.8591	0.8581	0.8666	0.8746	0.8817
IVB	0.8256	0.8357	0.8453	0.8544	0.8624
IVC	0.7918	0.8034	0.8145	0.8250	0.8343
95-99	-	0.9235	0.9284	0.9331	0.9374
	-	0.8978	0.9041	0.9102	0.9159
IIIA	0.8613	0.8697	0.8776	0.8851	0.8916
IIIB	0.8593	0.8488	0.8577	0.8662	0.8737
IVA	0.8660	0.8625	0.8365	0.8461	0.8544
IVB	0.7886	0.8003	0.8115	0.8222	0.8316
IVC	0.7998	0.7630	0.7757	0.7879	0.7987
90-91	-	0.9049	0.9189	0.9165	0.9219
	-	0.8837	0.8814	0.8887	0.8956
IIIA	0.8503	0.8488	0.8577	0.8662	0.8737
IIIB	0.8046	0.8156	0.8261	0.8361	0.8449
IVA	0.7775	0.7896	0.8013	0.8124	0.8222
IVB	0.7661	0.7594	0.7723	0.7846	0.7959
IVC	0.7025	0.7173	0.7316	0.7454	0.7577
85-89	-	0.8848	0.8919	0.8986	0.9049
	-	0.8461	0.8571	0.8656	0.8737
IIIA	0.7980	0.8093	0.8201	0.8304	0.8394
IIIB	0.7666	0.7811	0.7931	0.8046	0.8147
IVA	0.7382	0.7518	0.7649	0.7775	0.7887
IVB	0.7034	0.7181	0.7324	0.7462	0.7584
IVC	0.6559	0.6718	0.6874	0.7026	0.7161
80-81	-	0.8639	0.8721	0.8799	0.8872
	-	0.8219	0.8321	0.8419	0.8512
					0.8593

111A	0.7655	0.7761	0.7902	0.8018	0.8121
111B	0.7330	0.7468	0.7601	0.7729	0.7842
111A	0.6997	0.7145	0.7289	0.7428	0.7552
111B	0.6621	0.6780	0.6834	0.7084	0.7218
111C	0.6116	0.6285	0.6451	0.6613	0.6758
76-79	-	0.8199	0.8493	0.8582	0.8667
111A	-	0.7932	0.8038	0.8148	0.8254
111B	-	0.7295	0.7434	0.7568	0.7698
111A	0.6991	0.7091	0.7236	0.7377	0.7502
111B	0.6582	0.6741	0.6896	0.7048	0.7182
111C	0.6133	0.6350	0.6514	0.6675	0.6819
111C	0.5635	0.5830	0.6003	0.6174	0.6328
70-75	-	0.7776	0.7898	0.801	0.8126
111A	-	0.7177	0.7320	0.7558	0.7592
111B	-	0.6427	0.6590	0.6749	0.6904
111A	0.6020	0.6191	0.6358	0.6522	0.6670
111B	0.5622	0.5797	0.5971	0.6142	0.6296
111C	0.5192	0.5371	0.5548	0.5724	0.5894
111C	0.4647	0.4825	0.5004	0.5183	0.5347
NHS GRAD	6-11	12-17	18-23	24-29	30-34
115+	-	0.9701	0.9721	0.9740	0.9757
111A	-	0.9553	0.9620	0.9645	0.9669
111B	-	0.9444	0.9471	0.9496	0.9539
111A	0.9334	0.9378	0.9418	0.9456	0.9489
111B	0.9225	0.9275	0.9321	0.9365	0.9403
111C	0.9032	0.9149	0.9203	0.9254	0.9298
111C	0.8895	0.8963	0.9028	0.9089	0.9142
110-114	-	0.9527	0.9558	0.9587	0.9615
111A	-	0.9380	0.9402	0.9441	0.9478
111B	-	0.9119	0.9175	0.9228	0.9277
111A	0.8910	0.9034	0.9095	0.9152	0.9202
111B	0.8806	0.8861	0.8951	0.9016	0.9073
111C	0.8614	0.8697	0.8776	0.8851	0.8916
111C	0.8332	0.8429	0.8522	0.8610	0.8686
105-109	-	0.9380	0.9420	0.9458	0.9494
111A	-	0.9166	0.9219	0.9269	0.9316
111B	-	0.8861	0.8931	0.8997	0.9060
111A	0.8674	0.8754	0.8830	0.8902	0.8965
111B	0.8414	0.8564	0.8650	0.8731	0.8802
111C	0.8216	0.8338	0.8435	0.8527	0.8608
111C	0.7836	0.8012	0.8124	0.8231	0.8324
100-104	-	0.9191	0.9243	0.9291	0.9337
111A	-	0.8920	0.8987	0.9050	0.9110
111B	-	0.8559	0.8626	0.8708	0.8787
111A	0.8309	0.8407	0.8501	0.8590	0.8658
111B	0.8066	0.8175	0.8280	0.8379	0.8467
111C	0.7762	0.7903	0.8019	0.8131	0.8228
111C	0.7382	0.7518	0.7649	0.7775	0.7887
95-99	-	0.9195	0.925	0.9318	0.9377
111A	-	0.8668	0.8749	0.8825	0.8913
111B	-	0.8215	0.8318	0.8416	0.8497
111A	0.7917	0.8062	0.8162	0.8276	0.8368
111B	0.7667	0.7793	0.7913	0.8029	0.8131
111C	0.7383	0.7461	0.7613	0.7741	0.7854
111C	0.6896	0.7047	0.7194	0.7336	0.7462
90-94	-	0.8758	0.8834	0.8906	0.8974
					0.9033

CURRENT ABILITY DISTRIBUTION OF ACCESSIONS ENTERING TRAINING

HS	NHS	IVC			IVB			IVC		
		II	IIIA	IIIB	IIA	IIIB	IVA	II	IIIA	IIIB
I	798.	1072.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	1086.	1115+	1110-1114
	145.	1086.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	992.	1115+	1110-1114
	64.	992.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	428.	1115+	1110-1114
	100-104	603.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	442.	1115+	1110-1114
	95-94	513.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	477.	1115+	1110-1114
	6.	324.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	431.	1115+	1110-1114
	85-89	125.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	191.	1115+	1110-1114
	80-84	115.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	185.	1115+	1110-1114
	76-79	67.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	145.	1115+	1110-1114
	70-75	0.	4.	2.	4.	2.	4.	10.	30.	45.
I	104.	363.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	104.	1115+	1110-1114
	26.	454.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	505.	1115+	1110-1114
	14.	329.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	355.	1115+	1110-1114
	10.	311.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	333.	1115+	1110-1114
	9.	129.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	492.	1115+	1110-1114
	4.	116.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	234.	1115+	1110-1114
	80	116.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	607.	1115+	1110-1114
	2.	106.	1115+	1110-1114	1110-1114	1110-1114	1110-1114	691.	1115+	1110-1114

80-84	0.	98.	215.	539.	1173.	1244.	119.
76-79	0.	61.	134.	411.	1092.	1376.	175.
70-75	0.	2.	2.	6.	20.	33.	6.

CURRENT SET OF PROPORTION ASSUMPTIONS WITH BASELINE=OUT-SCORE 76+

	HS	I	II	III A	III B	IV A	IV B	IV C
115+	0.01958763	0.02631320	0.00287187	0.00105547	0.00019637	0.00004909	0.000117182	0.00004909
110-114	0.00155916	0.02656685	0.00611193	0.00277369	0.00071183	0.00022091	0.00022091	0.00022091
105-109	0.00157094	0.0243953	0.00505548	0.00610829	0.000230731	0.00066274	0.0001223	0.0001223
100-104	0.00044183	0.01480118	0.01084929	0.00910653	0.00050545	0.00162003	0.00071183	0.00071183
95-99	0.00022091	0.0125204	0.0170839	0.01592029	0.01045655	0.00581738	0.00191438	0.00191438
90-94	0.00014728	0.0079287	0.01057928	0.01750122	0.01165903	0.01367206	0.00635739	0.00635739
85-89	0.00007364	0.0030824	0.00688163	0.00898380	0.01219931	0.01219931	0.006622739	0.006622739
80-84	0.00007364	0.00262278	0.00454059	0.01210113	0.02120166	0.02394006	0.01794305	0.01794305
76-79	0.00007364	0.00164458	0.00355916	0.00991654	0.0201325	0.02901325	0.00898871	0.00898871
70-75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NHS	I	II	III A	III B	IV A	IV B	IV C
115+	0.00255277	0.00891016	0.00176730	0.0093274	0.00024546	0.00007364	0.00004909	0.00004909
110-114	0.00063819	0.0114384	0.00434462	0.0289642	0.00110457	0.00019637	0.0	0.0
105-109	0.00014364	0.01239568	0.00807560	0.0763377	0.00316642	0.00117820	0.00017182	0.00017182
100-104	0.00014728	0.00871759	0.00819833	0.0924835	0.00709376	0.00247332	0.00022091	0.00022091
95-99	0.00009818	0.01081178	0.01207658	0.01870397	0.01752577	0.00858743	0.00068729	0.00068729
90-94	0.00004909	0.00574474	0.01033382	0.0205037	0.02619047	0.02024491	0.00142366	0.00142366
85-89	0.00004909	0.00218558	0.00141826	0.01696122	0.01563155	0.014775	0.0014775	0.0014775
80-84	0.0	0.00240550	0.00527737	0.0132024	0.02879234	0.0305310	0.002929096	0.002929096
76-79	0.0	0.00149130	0.003288915	0.01008836	0.02459499	0.03382425	0.00429553	0.00429553
70-75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		I-III	III A	III B	IV			
HS	0.14524948	0.06561112	0.08667687	0.23870856	0.25017142			
NHS	0.06504655	0.05778103	0.09305340					

MATRIX OF PROPORTIONS USED FOR FIXED MARGINALS COMPUTATIONS

	HS	I	II	III A	III B	IV A	IV B	IV C
115+	0.01664954	0.02236650	0.00244110	0.00897116	0.00016691	0.0004173	0.00014605	0.00014605
110-114	0.00265259	0.02065810	0.00531916	0.0235764	0.00660505	0.00018758	0.00018758	0.00018758
105-109	0.001313530	0.02069718	0.00592983	0.0531207	0.00196122	0.0056333	0.00010432	0.00010432
100-104	0.000317555	0.01258105	0.00922192	0.0771058	0.00429800	0.00137703	0.00065506	0.00065506
95-99	0.00018778	0.01070327	0.00995217	0.1354079	0.00888810	0.00494479	0.00162740	0.00162740
90-94	0.00012518	0.00675996	0.00999242	0.1487609	0.01410412	0.01162130	0.00540380	0.00540380
85-89	0.00008259	0.00260801	0.0045195	0.0763525	0.0136945	0.01036945	0.0036945	0.0036945
80-84	0.00008259	0.00239937	0.0036986	0.01028600	0.00802657	0.0198002	0.0125165	0.0125165
76-79	0.00006259	0.00139789	0.00302529	0.0084909	0.01731719	0.02466335	0.00464049	0.00464049
70-75	0.00006453	0.00144128	0.00311918	0.00862067	0.01785461	0.02540517	0.002540517	0.002540517
	NHS	I	II	III A	III B	IV A	IV B	IV C
115+	0.00216987	0.00757366	0.00150221	0.00079284	0.00006559	0.00004173		
110-114	0.00051247	0.00947210	0.00639294	0.00246196	0.00003888	0.00016591	0.0	
105-109	0.00029210	0.01053636	0.00656428	0.00648873	0.00100148	0.00014605	0.00014605	

100-104	0.00012518	0.00740675	0.00696860	0.00811613	0.00602972	0.00242023	0.00016778
95-99	0.00008346	0.00694774	0.0106513	0.01589443	0.0149696	0.0074634	0.00028419
90-94	0.00004173	0.00488219	0.0087376	0.01721287	0.0226198	0.0172313	0.00121012
85-89	0.00004173	0.00185690	0.0037554	0.0083091	0.01441709	0.01320597	0.00125185
80-84	0.00004173	0.00204488	0.0048977	0.0124514	0.02407357	0.02595912	0.00268283
75-79	0.00004173	0.00127271	0.0029579	0.00857314	0.02050582	0.02875071	0.00365121
70-75	0.00004173	0.000131221	0.00288255	0.00884125	0.0215460	0.02964295	0.00376453

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 115+

	I	II	III	IV	V	VI	IVC
I-11		111A	111B	111B	IV		
HS	0.03901585	0.00244110	0.00897116	0.00033469			
NHS	3.00974352	0.00150221	0.00079284	0.00031296			

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 115+

	I	II	III	IV	V	VI	IVB	IVC
115+		0.40853620	0.04458837	0.01638718	0.00304878	0.00076219	0.00266768	
NHS	1	11	111A	111B	11A	IVB		IVC
115+	0.03963411	0.13833821	0.02743899	0.01448169	0.0	0.0	0.0	0.0
I-11		111A	111B	IV				
HS	0.71265179	0.04458837	0.01638718	0.00647865	0.0			
NHS	0.17797232	0.02743899	0.01448169					

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 110+

	I	II	III	IV	V	VI	IVB	IVC
I-11		111A	111B	111B	IV			
HS	0.06669953	0.00763625	0.00325480	0.00133530				
NHS	0.01975828	0.00519516	0.00325480	0.00141876				

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 110+

	I	II	III	IV	V	VI	IVB	IVC
115+		0.15836489	0.21274084	0.02321891	0.0083345	0.00158162	0.0039690	0.00138917
110-114	0.02877556	0.21551913	0.04941460	0.02242511	0.00575511	0.00178607	0.00178607	

		I		II		III A		III B		IV A		IV B		IV C	
		NHS	115+	NHS	110-114	NHS	0.02063903	NHS	0.00515975	NHS	0.61540043	NHS	0.18793116	NHS	0.014270093
		I-11	I-11	IIIA	IIIA	IIIB	IIIB	IIIB	IIIB	IIIB	IV A	IV A	IV B	IV B	IV C

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 105+

		I		II		III A		III B		IV	
		HS	NHS	HS	NHS	HS	NHS	HS	NHS	HS	NHS
		I-11	I-11	IIIA	IIIA	IIIB	IIIB	IIIB	IIIB	IV	IV

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 105+

		I		II		III A		III B		IV A		IV B		IV C	
		HS	NHS	HS	NHS	HS	NHS	HS	NHS	HS	NHS	HS	NHS	HS	NHS
		I-11	I-11	IIIA	IIIA	IIIB	IIIB	IIIB	IIIB	IV A	IV A	IV B	IV B	IV C	IV C

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 100+

		I		II		III A		III B		IV	
		HS	NHS	HS	NHS	HS	NHS	HS	NHS	HS	NHS
		I-11	I-11	IIIA	IIIA	IIIB	IIIB	IIIB	IIIB	IV	IV

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 100+

PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 100+

		I	II	III A	III B	IV A	IV B	IV C
HS		0.07331866	0.09849322	0.010761973	0.00395076	0.00073503	0.00018376	0.00064315
115+	0.01332231	0.09977949	0.02287762	0.0138222	0.00266447	0.00082690	0.00082690	0.00082690
110-114	0.005880.9	0.0914295	0.03932378	0.0361265	0.00863655	0.00045939	0.00045939	0.00045939
105-109	0.00165380	0.05540246	0.04661007	0.03408676	0.01392689	0.00603396	0.00603396	0.00603396
100-104								
NHS		I	II	III A	III B	IV A	IV B	IV C
115+	0.00955531	0.03335172	0.00661521	0.00349137	0.0	0.0	0.0	0.0
110-114	0.00238883	0.04171263	0.01625241	0.0084161	0.0	0.0	0.0	0.0
105-109	0.00128629	0.04659840	0.03022786	0.02857407	0.0	0.0	0.0	0.0
100-104	0.00055127	0.03261669	0.03068725	0.03574057	0.0			
	I-11	III A	III B	IV				
HS	0.43899304	0.11356109	0.07203233	0.04511216				
NHS	0.16186098	0.08319269	0.07666755	0.0				

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 95+

	I-11	III A	III B	IV
HS	0.11057949	0.03574017	0.02989823	0.02570454
NHS	0.04514986	0.02923317	0.03337509	0.03681596

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 95+

		I	II	III A	III B	IV A	IV B	IV C
HS		0.053686678	0.07212055	0.007781137	0.00289290	0.00053821	0.00013455	0.00047094
115+	0.00975512	0.0730242	0.0165189	0.01761226	0.00193102	0.00060559	0.00060559	0.00060559
110-114	0.0040571	0.06677843	0.02879442	0.01720110	0.00632401	0.00181647	0.00181647	0.00181647
105-109	0.00121098	0.04055783	0.02973629	0.02195965	0.01383899	0.000440026	0.000440026	0.000440026
100-104	0.00060549	0.03451291	0.03209098	0.04366257	0.028662988	0.015941158	0.015941158	0.015941158
NHS		I	II	III A	III B	IV A	IV B	IV C
115+	0.00699677	0.02442142	0.00464392	0.00255651	0.0	0.0	0.0	0.0
110-114	0.0074919	0.0305361	0.01190797	0.00191865	0.0	0.0	0.0	0.0
105-109	0.00094187	0.03397471	0.02213403	0.02092304	0.0	0.0	0.0	0.0
100-104	0.00040366	0.0238321	0.02247041	0.02617063	0.0	0.0	0.0	0.0
9-99	0.000265911	0.0220312	0.03310013	0.05126484	0.0	0.0	0.0	0.0
	I-11	III A	III B	IV				
HS	0.35656595	0.11544493	0.09640741	0.08268485				
NHS	0.14558655	0.09445643	0.10885364	0.0				

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES PROPORTION ASSUMPTIONS FOR ATTITUDE AREA CUT-SCORE

		I-11	III A	III B	IV
15	0.11746660	0.04473259	0.04477133	0.05683376	
	0.05003736	0.0307695	0.0509796	0.0755172	

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
PROPORTION ASSUMPTIONS FOR ATTITUDE AREA CUT-SCORE 90+

HS	I	II	IIIA	IIIB	IVA	IVB	I _{VC}
115+	0.04132148	0.05550954	0.00605841	0.00222660	0.00041425	0.00010356	0.00036247
110-114	0.00750829	0.05623448	0.01289354	0.00585128	0.0150166	0.00104603	0.00044603
105-109	0.00314040	0.0516704	0.02216239	0.01330786	0.00486744	0.00139809	0.00025891
100-104	0.00093206	0.03122412	0.0288833	0.01921086	0.0166694	0.0034157	0.00150166
95-99	0.00046663	0.02626379	0.02469568	0.01360606	0.0258883	0.01227216	0.000403894
90-94	0.00031069	0.01677112	0.02231773	0.01692066	0.03500417	0.02888219	0.01341135
NHS	I	II	III A	IIIB	IV A	IVB	I _{VC}
115+	0.00538525	0.01879660	0.00372825	0.00196769	0.0	0.0	0.0
110-114	0.00134653	0.0230871	0.00916529	0.00611020	0.0	0.0	0.0
105-109	0.00012494	0.02614954	0.0170304	0.01610398	0.0	0.0	0.0
100-104	0.00031069	0.01821069	0.01729694	0.014293	0.0	0.0	0.0
95-99	0.00020713	0.01743131	0.02547639	0.01945731	0.0	0.0	0.0
90-94	0.00010356	0.01211682	0.0217991	0.014271928	0.0	0.0	0.0
I-III	IIIA	IIIB	IV				
HS	0.29152828	0.11101896	0.11112255	0.14105213			

**MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS, PERCENTAGES
PROPORTION ASSUMED JNS WITH FIXED MARGINAL TYPE**

	HS	NHS	HS	NHS
I-11			111A	111B
	0.12013519	0.05197241	0.04888454 0.04818248	0.05241058 0.05927180
				IV

ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 64+

	I-11	III A	III B	IV
HS	0.22487509	0.09614692	0.11500186	0.24998075
NHS	0.09906134	0.08459569	0.12935317	0.0

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 76+

	I-11	III A	III B	IV
HS	0.12405753	0.05516969	0.07112563	0.20290297
NHS	0.05528580	0.04911404	0.07905563	0.21264642

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 76+

	I	II	III A	III B	IV A	IV B	IV C
HS	0.02612282	0.03509231	0.00383004	0.00140762	0.000026188	0.00006547	0.000022915
115+	0.00471663	0.03550506	0.0085110	0.00369910	0.00094933	0.00029162	0.00029462
110-114	0.00209106	0.03267348	0.01401073	0.00841999	0.00307113	0.00088386	0.00016368
105-109	0.00029162	0.01973942	0.0146903	0.01214882	0.00674349	0.00216054	0.0009493
100-104	0.00019841	0.01679323	0.01561477	0.02124226	0.01394529	0.00775829	0.00255336
95-99	0.00009821	0.01060625	0.01410894	0.02334032	0.02212914	0.01823363	0.00867847
85-89	0.00009821	0.00409172	0.00651434	0.01198114	0.01626950	0.0162950	0.00883856
80-84	0.00009821	0.00376457	0.00652604	0.01613554	0.02282340	0.0310191	0.02392559
76-79	0.00009821	0.00219327	0.004744663	0.01322509	0.02717039	0.03869326	0.0386660
NHS	0.00340446	0.01186293	0.00235695	0.00124394	0.0	0.0	0.0
110-114	0.00085112	0.0146115	0.00519416	0.00386278	0.0	0.0	0.0
105-109	0.00043629	0.01653135	0.01016994	0.01018070	0.0	0.0	0.0
100-104	0.00019841	0.0162105	0.01093361	0.01273406	0.0	0.0	0.0
95-99	0.00013094	0.0109067	0.01610580	0.02494435	0.0	0.0	0.0
90-94	0.00006547	0.00766007	0.01278158	0.02700869	0.0	0.0	0.0
85-89	0.00006547	0.00320807	0.00291385	0.00703810	0.01302668	0.0	0.0
80-84	0.0	0.00196866	0.00438654	0.01342424	0.0	0.0	0.0
76-79	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	I-11	III A	III B	IV	IV B	IV C	IV
HS	0.19464391	0.08750153	0.11159480	0.31835157	0.0	0.0	IV
NHS	0.088674642	0.07705891	0.12409973				

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7

MATRIX OF PROPORTIONS FOR COMPUTING MARGINALS PERCENTAGES
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 70+

	I-11	III A	III B	IV
HS	0.19464391	0.08750153	0.11159480	0.31835157
NHS	0.088674642	0.07705891	0.12409973	

		HS	0.12256326	0.05886886	0.07981628	0.227158940
		NHS	0.05660200	0.05199659	0.06793688	0.26760846

PROPORTION ASSUMPTIONS WITH FIXED MARGINAL TYPE 7
PROPORTION ASSUMPTIONS FOR APTITUDE AREA CUT-SCORE 70+

		HS	I	II	III A	III B	IV A	IV B	IV C
115+		0.02273302	0.03053859	0.00333304	0.00122496	0.00022790	0.0005698	0.00019941	
110-114		0.00413068	0.0309742	0.00109338	0.00321909	0.00082614	0.00025639	0.00022639	
105-109		0.00182320	0.02822959	0.01219255	0.0072128	0.00267783	0.00076916	0.00014244	
100-104		0.00051277	0.0171796	0.01259147	0.01056886	0.00566882	0.0018018	0.00082614	
95-99		0.00025639	0.01461408	0.01358854	0.01213588	0.01675154	0.00675154	0.00222203	
90-94		0.00017092	0.00922994	0.01227811	0.02031159	0.01925757	0.01566755	0.00737827	
85-89		0.00008546	0.0035094	0.00566901	0.01042642	0.01415830	0.01415830	0.00169163	
80-84		0.00008546	0.0032606	0.00527019	0.01496434	0.02461323	0.02703167	0.02082418	
76-79		0.00008546	0.00190866	0.000413062	0.01190895	0.03361226	0.03361226	0.03364318	
70-75		0.00008811	0.00195789	0.0004258888	0.01186612	0.02437883	0.0341724	0.03468787	
		NHS	I	II	III A	III B	IV A	IV B	IV C
115+		0.00296270	0.01031096	0.00205110	0.00108253	0.0	0.0	0.0	0.0
110-114		0.00074068	0.01293333	0.00504229	0.0036153	0.0	0.0	0.0	0.0
105-109		0.000139882	0.01436119	0.00937229	0.00865961	0.0	0.0	0.0	0.0
100-104		0.00017093	0.0101306	0.00951462	0.01108164	0.0	0.0	0.0	0.0
95-99		0.00011393	0.0094634	0.01401585	0.0210748	0.0	0.0	0.0	0.0
90-94		0.00005693	0.00665607	0.01199324	0.02330220	0.0	0.0	0.0	0.0
85-89		0.00005698	0.00251539	0.00512775	0.01133803	0.0	0.0	0.0	0.0
80-84		0.0	0.00279178	0.00612481	0.01534677	0.0	0.0	0.0	0.0
76-79		0.0	0.01173774	0.00381733	0.0110836	0.0	0.0	0.0	0.0
70-75		0.0	0.00119167	0.00393519	0.01201171	0.0	0.0	0.0	0.0
			I-11	III A	III B	IV			
HS			0.17144209	0.08040589	0.10897994	0.37082428			
NHS			0.07728338	0.0709527	0.12006772	0.0			

Appendix B

DOCUMENTATION OF 11B CGST-PERFORMANCE MODEL

The computer implementation of the cost-performance model utilizes the formulas defined in the report in calculating performance and cost measures. The following is a summary of these calculations.

A. Performance Definitions

P = the original baseline proportion matrix.

NBB = the category of aptitude scores (Combat Arms for infantry) corresponding to the baseline cut-off score.

NB = the category of aptitude scores (Combat Arms for infantry) corresponding to a new cut-off score.

P'(NB) = the matrix of proportions under the new cut-off score NB.

A1 = accessions at baseline.

A(NB) = accessions entered at new cut-off score NB.

B = the matrix of rates of passing basic training.

T = the matrix of rates of completing advanced training.

R = the matrix of rates of completing IM months of service.

S = the matrix of rates of passing the SQT.

IM = length of time intervals of service (in months).

I = categories of aptitude scores (limit = NBB or NR).

J = categories of AFQT (limit = JL).

K = categories of high school status (1 = high school graduate, 2 = nongraduate).

L = categories of optional dimension (not in use; limit = LL).

M = number of successive time intervals of service (limit = ML).

B. Performance Calculations

(1) Manpower at baseline

(a) Retained man-months = RMM(NBB)

$$RMM(NBB) = A1 \sum_{j=1}^{JL} \sum_{i=1}^{NBB} \sum_{k=1}^2 \sum_{l=1}^{LL} P_{j,i,k,l} \cdot B_{j,k,l} \cdot T_{i,k,l} \cdot \sum_{m=1}^{ML} R_{m,j,k,l} \cdot IM_m$$

PBTR (NBB)

(b) Qualified man-months = QMM(NBB)

$$QMM(NBB) = A1 \sum_{j=1}^{JL} \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} \cdot P_{j,i,k,l} \cdot B_{j,k,l} \cdot T_{i,k,l} \cdot \sum_{m=1}^{ML} I_{m,j,i,k,l} \cdot S_{m,j,i,k,l} \cdot IM$$

PBTRS (NBB)

(2) Manpower at a new cut-off score:

The new matrix of proportions, P' , is obtained either by adjusting each cell proportionately (option 1), or by adjusting cells proportionately with added constraints of fixed marginals (option 2; 8 methods of fixing marginals).

Option 1

$$P'_{j,i,k,l} = \frac{P_{j,i,k,l}}{\sum_{j=1}^{JL} \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} P_{j,i,k,l}} \quad \text{for} \quad \begin{array}{l} j = 1, JL \\ i = 1, NB \\ k = 1, 2 \\ l = 1, LL \end{array}$$

Option 2

Example: High school graduates = 65% of accessions
 AFQT IV's (HS graduates) = 20% of accessions
 AFQT IV's (nongraduates) = 0% of accessions

$$P'_{j,i,k,l} = 0 \quad \text{for} \quad \begin{array}{l} j = 5, 7 \\ i = 1, NB \\ k = 2 \\ l = 1, LL \end{array}$$

$$P'_{j,i,k,l} = \left[\frac{P_{j,i,k,l}}{\sum_{j=5}^7 \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} P_{j,i,k,l}} \right] \cdot 0.20 \quad \text{for} \quad \begin{array}{l} j = 5, 7 \\ i = 1, NB \\ k = 1 \\ l = 1, LL \end{array}$$

$$P'_{j,i,k,l} = \left[\frac{P_{j,i,k,l}}{\sum_{j=1}^4 \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} P_{j,i,k,l}} \right] \cdot 0.45 \quad \text{for} \quad \begin{array}{l} j = 1, 4 \\ i = 1, NB \\ k = 1 \\ l = 1, LL \end{array}$$

$$P'_{j,i,k,l} = \left[\frac{P_{j,i,k,l}}{\sum_{j=1}^4 \sum_{i=1}^{NB} \sum_{k=2}^2 \sum_{l=1}^{LL} P_{j,i,k,l}} \right] \cdot 0.35 \quad \text{for} \quad \begin{array}{l} j = 1,4 \\ i = 1,NB \\ k = 2 \\ l = 1,LL \end{array}$$

(3) Retained man-months at cut-off score NB = RMM(NB)

$$RMM(NB) = A(NB) \cdot \sum_{j=1}^{JL} \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} P'_{j,i,k,l} \cdot B_{j,k,l} \cdot T_{i,k,l} \cdot \sum_{m=1}^{ML} R_{m,j,k,l} \cdot IM_m$$

{ PBTR(NB) }

(4) Qualified man-months at cut-off score NB = QMM(NB)

$$QMM(NB) = A(NB) \cdot \sum_{j=1}^{JL} \sum_{i=1}^{NB} \sum_{k=1}^{KL} \sum_{l=1}^{LL} P'_{j,i,k,l} \cdot B_{j,k,l} \cdot T_{i,k,l} \cdot \sum_{m=1}^{ML} R_{m,j,k,l} \cdot S_{m,j,i,k,l} \cdot IM_m$$

{ PBTRS(NB) }

(5) Either the number of retained man-months, the number of qualified man-months, or the number of accessions is held constant.

— If the item retained man-months (RMM) is held constant, then

$$RMM(NB) = RMM(NBB) \quad \text{for} \quad NB = 1,IL$$

and

$$A(NB) = RMM(NBB)/PBTR(NB)$$

$$QMM(NB) = A(NB) \cdot PBTRS(NB)$$

— If qualified man-months (QMM) are held constant, then

$$QMM(NB) = QMM(NBB) \quad \text{for} \quad NB = 1,IL$$

and

$$A(NB) = QMM(NBB)/PBTRS(NB)$$

$$RMM(NB) = A(NB) \cdot PBTR(NB)$$

— If accessions (A) are held constant, then

$$A(NB) = A(NBB) = A1 \quad \text{for } NB = 1, IL$$

and

$$RMM(NB) = A1 \cdot PBTR(NB)$$

$$QMM(NB) = A1 \cdot PBTRS(NB)$$

C. Cost Definitions

CB = Baseline per capita cost of recruiting I-IIIA HS graduates.

ϵ = Elasticity.

K = The ratio of I-IIIA HS graduates in the Army to I-IIIA HS graduates in the Infantry.

A* = Baseline accessions for a new force size.

H = Number of Army recruits for FY81 that are I-IIIA HS graduates, given old standards.

H' = Number of Infantry recruits for FY81 that are I-IIIA HS graduates, given old standards.

R = Number of recruiters at baseline.

V = Average variable cost per single recruiter.

P = Perceived 3-year pay.

D. Cost Calculations

(5) Cost of recruits at baseline = $C_A(NBB)$

If accessions are unchanged ($A^* = A(NBB) = A1$),

then

$$C_A(NBB) = A1 \cdot \underbrace{\sum_{j=1}^3 \sum_{i=1}^3 \sum_{k=1}^1 \sum_{l=1}^{LL} P_{j,i,k,l}}_{P_H} \cdot CB = B$$

(6) If accessions are changed from original baseline value and the Bonus Method of recruiting is assumed, then

$$\Delta H' = P_H (A^* - A1)$$

$$C_A(NBB) = (H' + \Delta H')P \cdot \left[\left(\frac{H + K\Delta H'}{H} \right)^{1/\epsilon} - 1 \right] + B$$

(7) If accessions are changed from original baseline value and the Recruiter Method of recruiting is assumed, then

$$C_A(NBB) = \frac{VR}{K} \cdot \left[\left(\frac{H + K\Delta H'}{H} \right)^{1/\epsilon} - 1 \right] + B$$

Cost of recruits at new cut-off scores = $C_A(NB)$:

$$\Delta H' = A(NB) \sum_{j=1}^3 \sum_{i=1}^{NB} \sum_{k=1}^1 \sum_{l=1}^{LL} P_{j,i,k,l} - P_H A1$$

(8) Bonus Method

$$C_A(NB) = (H' + \Delta H')P \cdot \left[\left(\frac{H + K\Delta H'}{H} \right)^{1/\epsilon} - 1 \right] + B$$

(9) Recruiter Method

$$C_A(NB) = \frac{VR}{K} \cdot \left[\left(\frac{H + K\Delta H'}{H} \right)^{1/\epsilon} - 1 \right] + B$$

(10) Cost of basic training at any cut-off score = $C_B(Nb)$:

$$C_B(NB) = A(NB) \sum_{j=1}^{JL} \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} P_{j,i,k,l} \cdot B_{j,k,l} \cdot CB$$

where CB = per capita cost of basic training.

(11) Cost of advanced training at any cut-off score = $C_T(NB)$:

$$C_T(NB) = A(NB) \sum_{j=1}^{JL} \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} P'_{j,i,k,l} \cdot B_{j,k,l} \cdot T_{i,k,l} \cdot CT$$

where CT = per capita cost of advanced training.

(12) Cost of retained man-months at a given cut-off score = $C_R(NB)$:

$$C_R(NB) = A(NB) \sum_{j=1}^{JL} \sum_{i=1}^{NB} \sum_{k=1}^2 \sum_{l=1}^{LL} P'_{j,i,k,l} \cdot B_{j,k,l} \cdot T_{i,k,l} \cdot \sum_{m=1}^{ML} R_{m,j,k,l} \cdot IM_m \cdot CD_m$$

where CD_m = monthly cost of active duty in time interval m .

(13) Total cost at a given cut-off score = $C(NB)$:

$$C(NB) = C_A(NB) + C_B(NB) + C_T(NB) + C_R(NB)$$

Comparison Variables

(14) Cost per accession at a given cut-off score = $CPA(NB)$:

$$CPA(NB) = C(NB)/A(NB)$$

(15) Qualified man-months per accession at a given cut-off score = $QPA(NB)$:

$$QPA(NB) = QMM(NB)/A(NB)$$

(16) Cost per qualified man-month at a given cut-off score = $CPQ(NB)$:

$$CPQ(NB) = CPA(NB)/QPA(NB)$$

Appendix C

ALTERNATIVE METHOD FOR DETERMINING OPTIMUM STANDARDS

In Sec. III it was stated that the cost-performance model assumed a constant force size when testing for an optimum aptitude standard. In this approach, the criterion minimized was cost per qualified man-month. Although this appears to be the most straightforward approach, it has two limitations. First, the optimal aptitude cutoff is not strictly independent of force size, primarily because the cost of recruiting additional high-ability personnel is an exponential function of the initial number of such personnel. Second, from some points of view the criterion of cost per qualified man-month is less informative than total cost.

It is possible to run the model in a different way so as to see how the optimum point is affected by differing force sizes and at the same time see how total costs vary. This second approach can also be used to select an optimum standard yielding the same retained force size dictated by present manning levels, in effect allowing determination of an optimal ability mix without implying a change in the existing force size.

Basically, this second approach uses total variable cost as the criterion, rather than cost per qualified man-month, and the model is run with varying numbers of accessions. For each accession assumption, total qualified man-month is held constant over varying aptitude cut-offs. The current (1981) accession goal for Infantry is 12,168 men. The model is run for this baseline number of accessions, and then the number of accessions is raised in increments of 500 men from 13,000 to 14,500 accessions.

The results are shown in Fig. C.1 and Table C.1. All results use recruiting cost assumption A as described in Sec. III. Accession assumption A, which is the baseline accession number of 12,168, shows a minimum total variable cost of about \$411 million at a low-aptitude cut-off of 89. That is to say, a cut-off of 89 produces the same number of qualified man-months as the baseline cut-off of 76, for a lower total cost. The problem is that, as shown in Table C.1, this optimum is attained by reducing the total accessions to 10,464, resulting in 6,564 retained (but more productive) men at the three-year point. This is lower than the current (baseline) retained men of 7,303 at three years.

This problem is resolved by considering larger numbers of accessions as shown by curves B, C, D, and E. Each curve has a minimum and therefore optimum point, and the optimum declines only gradually as the number of accessions (and, hence, retained force size) increases. Looking again at Table C.1, if one wishes to choose an optimum that yields the same number of retained men as at present, the choice would be assumption C, which yields an optimum cut-off of 87, about 11,700 accessions, and 7,300 retained men at three years. Note that this optimum cut-off is virtually identical to that shown in Fig. 12 (cost assumption A).

As a practical matter, then, the simpler approach used in Sec. III may be preferred, since the resultant optimal aptitude cut-off score is the same.

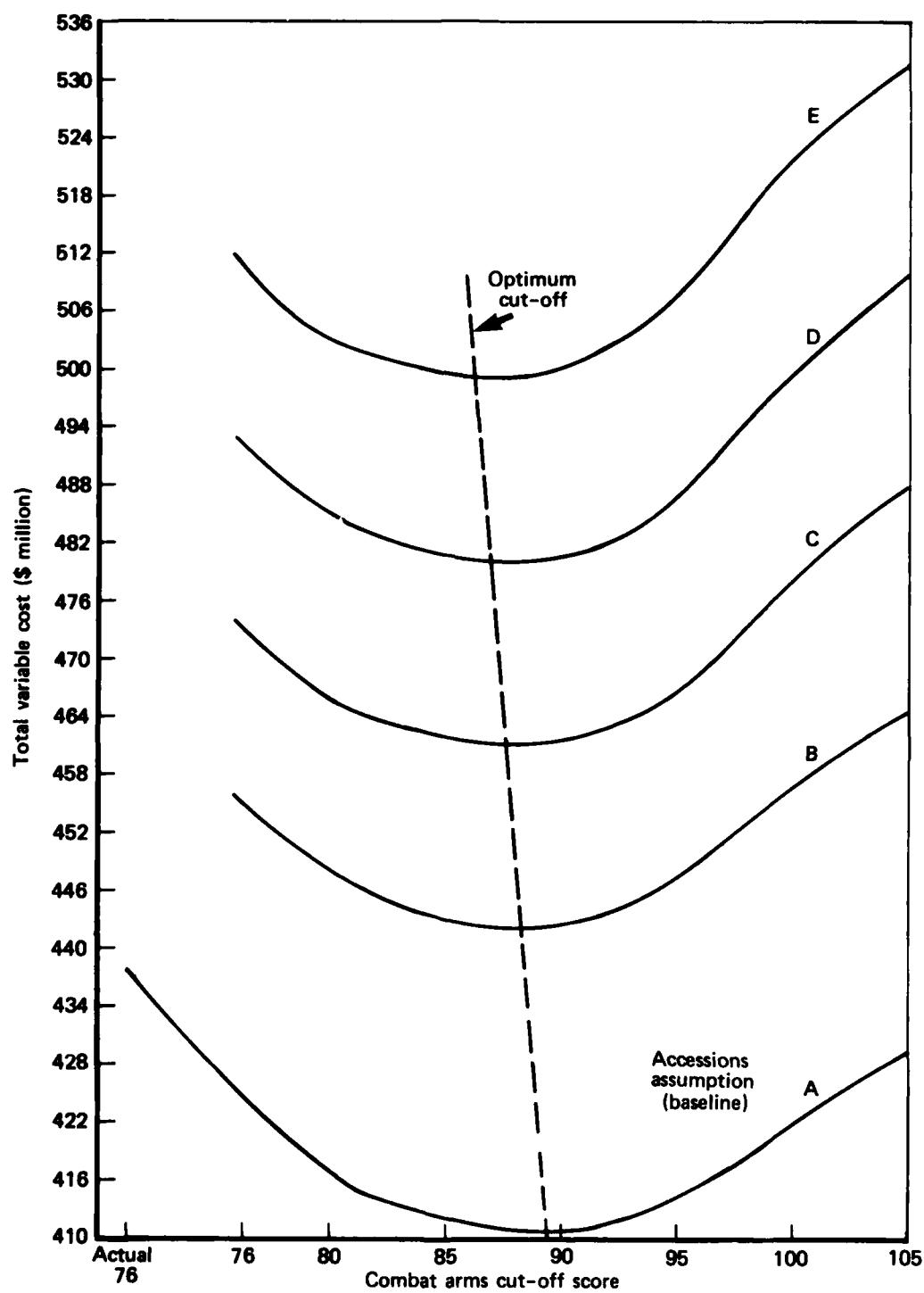


Fig. C.1—Optimum aptitude cut-offs for varying accession assumptions

Table C.1
FORCE SIZE CHARACTERISTICS FOR DIFFERING OPTIMAL CUT-OFFS

Item	Accessions Assumption				
	A ^a	B	C	D	E
Accessions at baseline	12,168	13,000	13,500	14,000	14,500
Optimum aptitude area cut-off score	89	88	87	87	86
Accessions using optimum cut-off	10,464	11,214	11,680	12,113	12,584
Retained men at 3 years using optimum cut-off	6,564 ^b	7,039	7,337	7,609	7,910

^aExisting baseline.

^bRetained men at pre-1971 cut-off is 7,303.

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